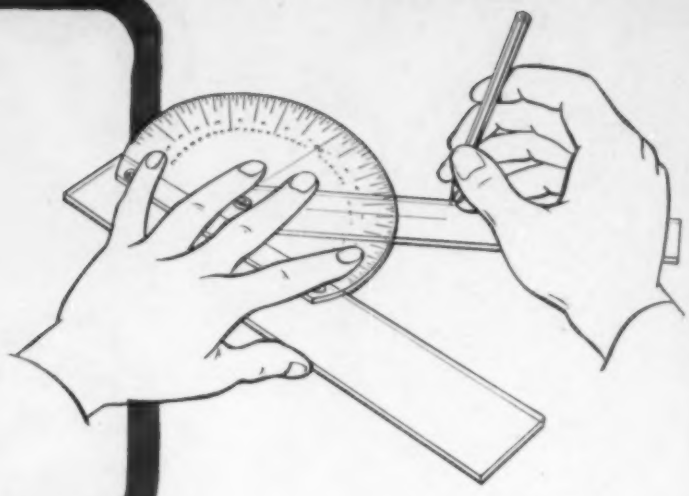
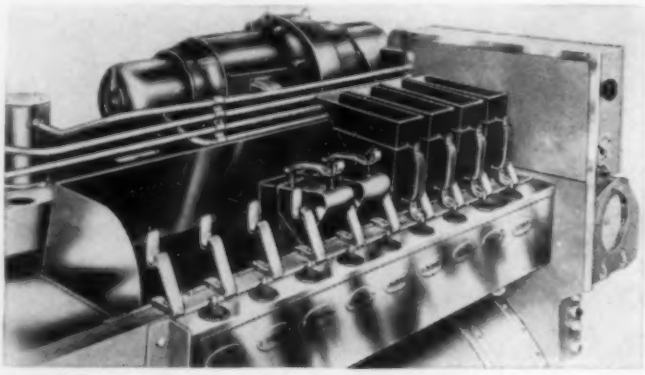
MODERN PLASTICS

DECEMBER 1944

DESIGN DATA ON PLASTICS



X. Meeting Unusual Chemical Resistance Requirements

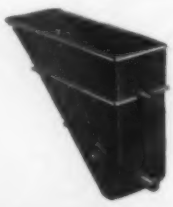


Among the many unusual materials problems confronting the design engineer of today is the particularly tough one of meeting requirements for chemical resistance.

As an excellent example of the solution of just this type problem, the successful development of triangular supply containers for the Robot Washer should prove of unusual interest to the design engineer. The Robot Washer, produced by the Robot Laundry Machinery Corporation, employs an entirely new principle in washing efficiency, using pre-mixed solutions that give uniform performance with no waste of water and supplies. Vital to the perfect performance of this washer are the plastic triangular supply containers (custom molded by the Plastic & Die Cast Products Corporation).

The selection of a plastic material for these containers presented a two-fold problem. First came the question of choosing a material that was resistant to the strong soaps, alkalies, and bleaches which the finished product would be called upon to hold. Secondly, were the stringent requirements for moldability for which the custom molding of such an intricate design called. Here was a genuine need for an unusually versatile plastic . . . to fit a specific job. *A Durez 75 type molding compound fulfilled that need perfectly.*

The versatility of the more than 300 Durez phenolic molding compounds has made their use practically universal throughout industry. Such properties as highest dimensional stability under all types of climatic conditions, chemical resistance, impact strength, heat and moisture resistance . . . render them invaluable to the design engineer. Add to the product versatility of Durez compounds the many new molding methods and processes developed by your custom molder, and you can readily appreciate the scope which is offered to imaginative minds. Many years experience in successful product development has filled the Durez files with a wealth of valuable data. These data, plus the full cooperation of experienced Durez technicians, are available at all times towards the successful solution of any materials problem which you may have. Durez Plastics & Chemicals, Inc., 512 Walck Road, North Tonawanda, N. Y.



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MODERN PLASTICS

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With Geon it's the *combination* of properties that counts

THE girl in the picture is demonstrating just one important property of GEON—heat sealing. This relatively new method of sealing has wide applications in many fields—textile, plastics, packaging, to name three important ones.

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Geon
Vinyl Resins & Plastics

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U.S.A.
June 21, 1944
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Melrose Park, Illinois
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Dear Mr. Neely:
During the past five years, we have used your Insurok grade C. G. as gibs and retainer plates on the high speed pneumatic sanders of our manufacture.
These sanders are used on practically every type sanding and finishing operation and are given considerable abuse on heavy work.
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It is obvious that we will find many more uses for your Insurok material in our development work here in the Pneumatic Machine Division of this company, and you may be assured that we will again call on you for your recommendations.
With kindest, personal regards, I am
Yours very truly,
SUNDSTRAND MACHINE TOOL CO.
Sales Manager
Pneumatic Machine Division
STUB

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For it points out facts that we already know . . . and want you to know.

Five years ago, Sundstrand installed gibs and retainer plates made of Laminated INSUROK in their pneumatic sanders. And in those five years, not one replacement was needed for these two vital parts. Some of these sanders worked in water . . . some in solvents . . . others finishing dry woods and metals.

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There are many grades and types of Laminated and Molded INSUROK. And Richardson Plasticians combine years of experience with the working knowledge of designers and manufacturers . . . a combination which allows INSUROK to meet practically every industrial requirement. Richardson will be glad to work with you in redesigning an old line of products, or in designing the needs of a new line. Write for complete information.

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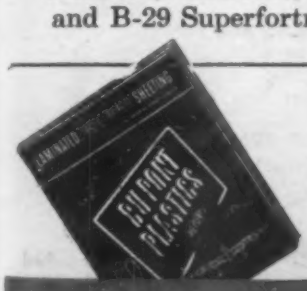
Tail compartment *of "Lucite" on the Northrop Black Widow. From this vantage point radio operator-gunner can ward off attack from above and below.*

Pilot housing *of "Lucite" provides clear side, top and forward vision for crew members of Northrop Black Widow.*



LAMINATED "LUCITE"—"BUTACITE" SHEETING for pressurized plane enclosures. Free 28-page "progress report" is yours for the asking on your business letterhead. Provides technical information on proof tests, property graphs, and application. Address: E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, N. J. or 5801 S. Broadway, Los Angeles 3, California. In Canada: Canadian Industries, Ltd., Box 10, Montreal.

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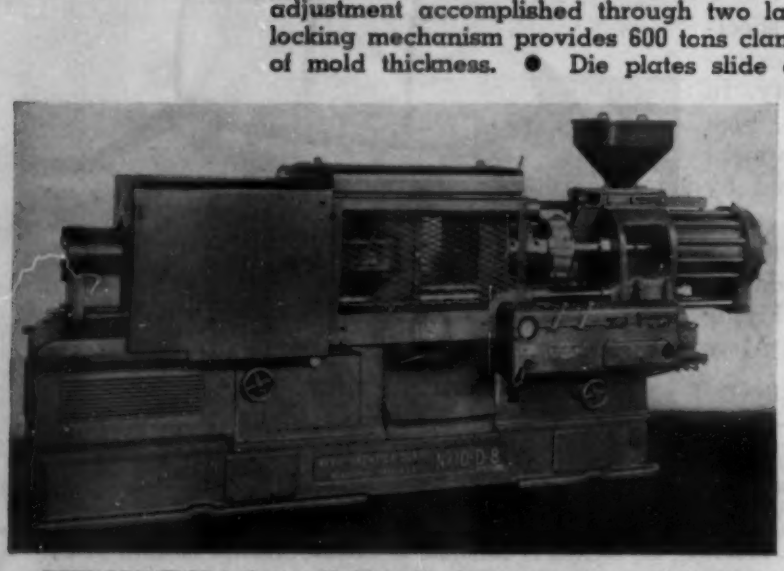

SPECIFICATIONS

Size of die plates	30" x 30"
Clearance between top and bottom frame members	29"
Maximum die height	20"
Minimum die height	8"
Weight, tons	14½
Motor required, 1200 RPM	40 H. P.

Send for Circular 10F — 22

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February 26, 1944

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A Celanese Plastic*

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Much credit for these advances must go to the molder. But working hand in hand with this industry, the Celanese development of Lumarith* molding materials has been an important factor. Because of Lumarith's moldability and free-flowing characteristics, together with its high impact strength and toughness, these plastics have always been in the vanguard of the steady march to ever-larger molded pieces.

If you have in mind large plastic parts, from refrigerator sections to housings of any type, you will find our Technical Service Department a good place to start the practical discussion. We welcome your inquiry. Celanese Celluloid Corporation, a *division of Celanese Corporation of America*, 180 Madison Avenue, New York 16, N. Y.

*Reg. U. S. Pat. Off.

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castles in the air,
in wild, fantastic shapes,
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For constructing
a cost-saving part
of any large or small device,
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busy but friendly,
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PROLON PLASTICS

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Out of a wartime test tube comes the new and greatly needed KIMPREG!* Not a plywood—not a conventional plastic laminate—KIMPREG is a remarkable surfacing material for bonding to the base plywood in conventional plywood hot presses. When applied to plywood, the finished product is more durable—has a higher flexural strength than ordinary plywood—offers resistance to vapor permeability, abrasion, decay. Application of KIMPREG assures moisture-resistance, easy washability. This new plastic surfacing material will make your product scuff-proof—it won't stain—the finish will wear better than paint.

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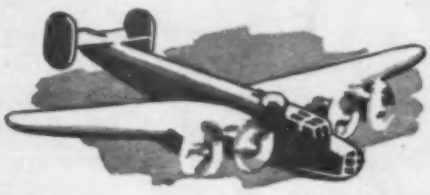
**KIMPREG (Trade-Mark) means Kimberly-Clark Plastic Surfacing Material*



TODAY—The Army and Navy use KIMPREG for bomber floors and doors, packing cases, luggage, hutments, parachute folding tables.

TOMORROW—KIMPREG will be used in construction of prefabricated houses, refrigerator car linings, table tops, piano and radio cases, etc.

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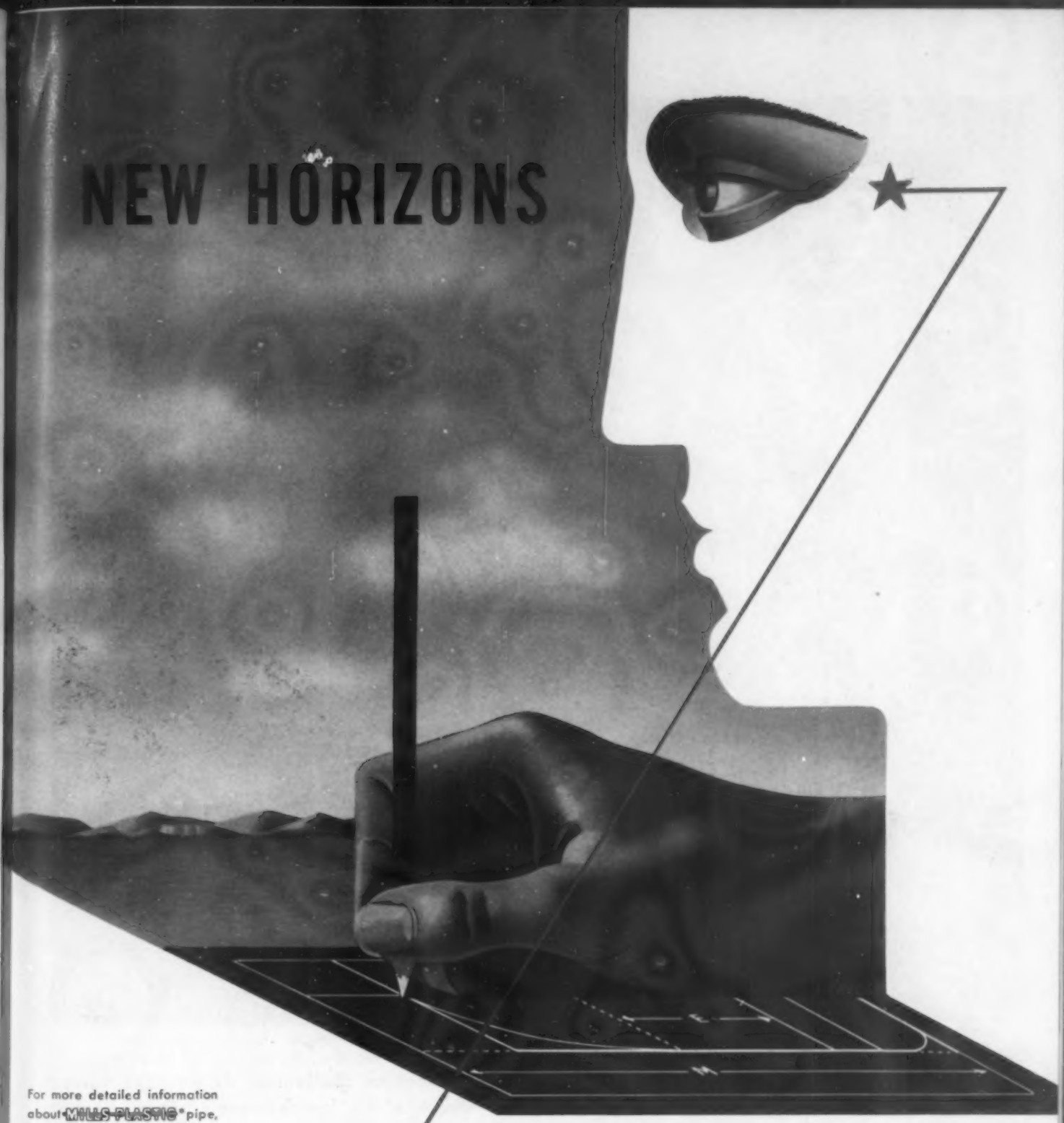

For more detailed information about MILLS-PLASTIC* pipe, tubing and fittings, write for circulars containing data and illustrations. Or, write on your letterhead for the new Injection Molded and Extruded Plastics catalog. *Tr. Mark Reg.

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Christmas . . . A season of traditional festivity . . . tempered this year by the thoughts of our loved ones away from home. To our boys and girls everywhere . . . our sincere wishes for a Very Merry Christmas. May this be our last Christmas at war . . . may the New Year bring us closer to ultimate world peace and happiness. In the contribution to a better life, American manufacturers will play as great a role in peace as they have in war. All we ask here at UNIVERSAL is the privilege of working with them in solving the problems of peacetime production as we have solved those of the last few years. Our extensive plant facilities and resources for the production of plastics moldings are at their disposal.

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PLASTICS CORPORATION

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THALID was born to meet the need for a better, stronger-bonding resin for structures employing glass cloth. These glass cloth-resin combinations provide structural strength, ease of fabrication.

THALID with an honorable service record and continuing war assignments, now looks forward to peacetime jobs, where the strong panels and shapes it produces indicate enormous possibilities. In furniture, in furniture components, housings of all kinds (refrigerator, radio, machine cabinets and housings), in boats, luggage, toys, in beautiful wall panellings and fixtures, for interiors or exteriors, the possibilities seem unlimited.

THALID FACTS:

THALID is a completely reactive thermo-setting resin used for producing high strength impression moldings.

THALID has a very rapid cure, at relatively low temperatures. After the molding has been raised to curing temperature (220°F.) it will set in 8 minutes at that temperature.

THALID completely cured produces a hard, infusible, insoluble, thermosetting material . . . rigid, with high fatigue resistance, high abrasion resistance.

THALID can be used to bond glass cloth, paper or cotton fabric. Fabric may be coated by brushing, transfer roll, or dip and squeeze roll methods.

THALID DESCRIPTION:

THALID X525 is furnished as a syrup with a viscosity of 18-22 poises. A catalyst is supplied separately. Viscosity may be varied by amount of styrene.

Complete information and answers to your particular production problems may be had direct from our plastics engineers. Write, wire or phone: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield, Massachusetts.

**Impression molding: A term covering the field variously described as low pressure molding, contact laminating, cast laminating or no pressure laminating.*

The broad and versatile Family of Monsanto Plastics includes: Lustron polystyrenes Cerex heat resistant thermoplastics • Vynate vinyl acetals • Nitron cellulose nitrates Fibestos cellulose acetates • Resinox phenolics • Resimene melamines. Forms in which they are supplied include: Sheets • Rods • Tubes • Molding Compounds • Industrial Resins • Coating Compounds • Vuepak rigid, transparent packaging materials.

MONSANTO PLASTICS

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—Industry's Armorplate!

To the molder, hard chromium plating is a performance guarantee—a production-wise insurance!

Compression and injection presses are stern masters . . . care nought for the time given over to tooling or to the cash given out for preparation—their only function is to pound out finished work. And, unless a die's surface is hard enough and tough enough to withstand steady punishment, its life is short—and far from sweet!

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The Source of CARDOLITE Resins

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The unique molecular structure of Cashew Nut Shell Liquid permits the development of resins for many new applications.

If you have a synthetic resin problem, we would like to have you tell us about it. Perhaps a Cardolite Resin is your solution. For information write Dept. 146.

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Compounds for vessels which must be highly resistant to caustics.

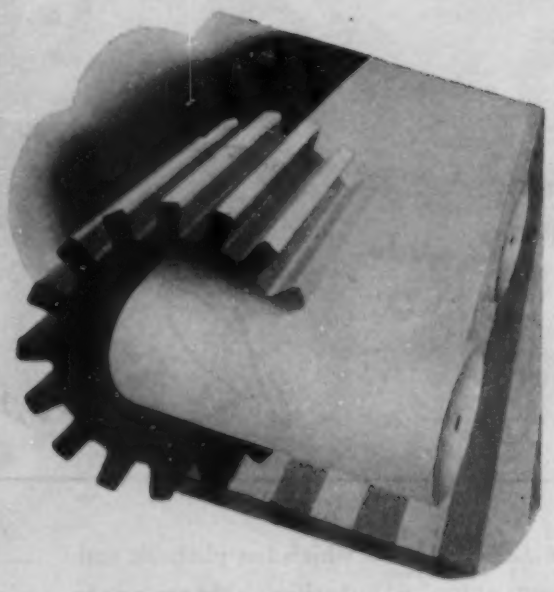
Liquid or powder to improve shock resistance of phenolic resins—used alone or in combination with phenolic resins.

IRVINGTON VARNISH & INSULATOR COMPANY • IRVINGTON, N. J.

Checklist of Popular

PLYOPHENS

From the complete line of Phenolic Varnishes and Resins Manufactured by America's Leading Producer of Synthetic Resins



In scores of different applications the versatile Plyophen line has successfully met every requirement of low-cost, availability, and results. Listed here are a few of the more widely used members of this great family—and RCI laboratories are constantly producing more. If you have a manufacturing problem involving phenolic resins or varnishes, get in touch with RCI.

P-398 For exterior plywood. Requires no catalyst . . . wood failure is exceptionally high . . . cures rapidly at moderate temperatures . . . requires only 75 to 250 pounds pressure.

No. 5000 Fast-curing resin for breaker strips, automobile sunvisors and general flat stock and structural laminates. Ordinarily employed with kraft paper. Cured at 1000 to 2000 pounds pressure psi.

No. 5031 Creosol base punching stock varnish, producing, with paper, laminates of the very best dielectric strength. Cures at 70 to 80 pounds steam pressure on platens. Hot punches especially well.

No. 5013 Low-pressure resin widely used with high strength paper using only 150 to 250 pounds pressure to produce a laminate with a tensile strength of 35,000 to 40,000 pounds.

No. 5015 Water-dilutable to as much as 10 parts water to 1 of resin. Exceptional penetration plus good water and chemical resistance gives it wide usefulness.

No. 5022 Exceptional curing speed—as rapid as 3 minutes with sheets .16 of an inch thick. Produces odorless laminates with excellent water resistance and mechanical properties and can be used for low or high pressure laminating.

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RCI is also headquarters for surface-coating resins including: Super-Beckacites for highest grade spar varnishes . . . Beckacites for architectural varnishes and enamels . . . Beckosols for all types of industrial and architectural finishes . . . Beckamines for imparting hardness to baked finishes.

RCI also supplies Beckamines for developing wet strength in papers as well as for water- and weather-resistance in fibreboard adhesives. Plyamines for plywood are another important RCI product.

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SYNTHETIC RESINS • CHEMICAL COLORS • INDUSTRIAL PLASTICS • INDUSTRIAL CHEMICALS

Speaking of Bonds..

United States of America

BUY * GIVE * HOLD

***Buy** U. S. War Bonds and you help to buy Victory. **Give** War Bonds and you contribute to our national heritage of freedom. **Hold** War Bonds until maturity and you fulfill your obligation to your country.*

This appeal contributed by Cordo Chemical Corporation, Norwalk, Connecticut, originators and manufacturers of CORDO-BOND Adhesives for the permanent bonding of metals, plastics, wood, glass, cloth, leather . . .

CORDO-BOND

PLASTICOS MEXICANA

After studying plastics engineering at Plastics Industries Technical Institute in 1940, Alejo Peralta returned to Mexico City and established a plastics molding firm known as Industrias Unidas, S.A. In the few years since, it has become the largest plant for electrical ware molding in Mexico.

Naturally we are pleased and proud that Señor Peralta has applied his Plastic Institute training so successfully—as have our graduates from all parts of the world. This is the reward for our ceaseless efforts to provide plastics instruction that enables a person to make his contribution to the industry.

Plastics Institute offers comprehensive, authoritative plastics training to those who seek a practical, useful education in this vital field. Your inquiries regarding our Resident and Home Study courses are invited.

Plastics
INDUSTRIES TECHNICAL
INSTITUTE

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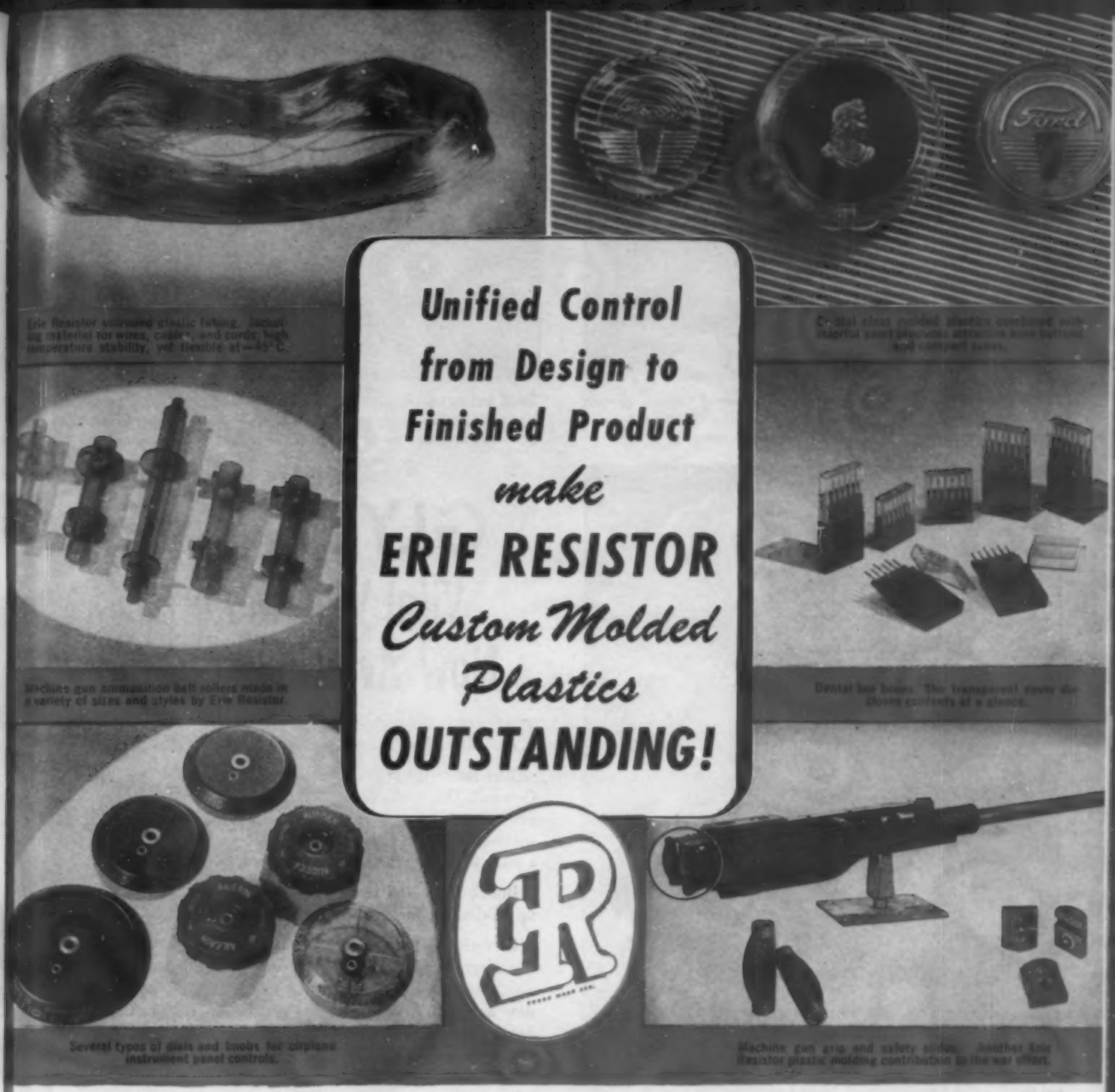
322 EAST 42ND ST., NEW YORK 17, N.Y. ★ 221 NORTH LASALLE ST., CHICAGO 1, ILL. ★ 186 SOUTH ALVARADO ST., LOS ANGELES 4, CALIF.



THE high quality of Erie Resistor Plastic Products reflects the knowledge and experience of Erie Resistor Engineers, coupled with a long established system of unified manufacturing control from drawing board to finished product.

We are therefore able to render exceptionally fine custom plastic molding service which embraces: 1. A thorough and up-to-date knowledge of molding materials, their characteristics, advantages and limitations for specific applications. 2. Years of experience in proper die design and the constant development of new molding techniques, resulting in higher production speeds (faster molding cycles), at the same time retaining the characteristics of high quality, such as close tolerance, controlled shrinkage, minimum of flow marks and unusual color depth. 3. The development and utilization of modern facilities and equipment for mechanical and finishing operations, such as drilling, tapping, machining, cementing, painting, buffing, and assembling.

Write our Engineering Department concerning any problem involving Injection or Extrusion Molding, or Injection Molded Thermosetting Plastic articles. Our new illustrated bulletin describes our facilities and background in detail. A letter to us will bring a copy to you.

Do More Than Before—
Buy EXTRA War Bonds

Plastics Division
ERIE RESISTOR CORP., ERIE, PA.
TORONTO, CANADA, LONDON, ENGLAND

Lower mortality rate of wounded has been brought about by such medicines as sulfa ointments, which are prepared with safe, non-toxic glycerine. Use glycerine in making drugs and cosmetics.

Good eating! Pure, wholesome glycerine is safe in foods and food products. It is used in many kinds of army concentrated foods. Use glycerine in your food processing! You're safe with glycerine!

Hit the nylon! Nylon, used in making parachute shrouds, glider tow lines and other war essentials, is made with glycerine. In many vital war applications, where life is at stake, glycerine is used!

GLYCERINE, Vital War Material, Now Available to You!

GLYCERINE, time-proven standby of American industry, is now off allocation. There is plenty of glycerine for civilian goods!

War needs for glycerine have been enormous. The Surgeon General's Office, the Medical Corps, the Ordnance Department and many other important agencies recognize the necessity of using *only* glycerine in the making of many vital articles. For a long while war needs came first on all glycerine produced.

But so successful have glycerine producers been in stepping up production that now there is plenty for civilian goods, too.

Glycerine is not toxic. Now that real glycerine is back, you don't have to put up with substitutes. Get back to safe, dependable glycerine in your present products. And when you plan new ones you'll want to use glycerine instead of substitutes. Send for the free booklet, "Nothing Takes the Place of Glycerine—1583 Uses For It". Glycerine Producers Association, 295 Madison Avenue, New York 17, N. Y.

Safe against gas—thanks to a cellophane bag—made with glycerine. Glycerine is favored in making cellophane. Since it is non-toxic, it is safe to use in cellophane for all kinds of purposes.

Glycerine and you. If you've been using emergency substitutes, you can now come back to safe, time-tested glycerine in making foods and food products, plastics, paints, textiles, drugs, cosmetics, etc.

Poly-tint.

A PERMANENT DIP-DYE FOR PLASTICS

Color plastics this convenient way

Poly-tint, a cold dip dye, rapidly colors transparent, translucent, or opaque plastic products. Readily available in standard colors which can be used to produce an infinite variety of colors and shades:

Poly-tint cold dip dyes are available in two types:

Poly-tint No. 1
for
METHYL METHACRYLATE

•

Poly-tint No. 2
for
CELLULOSE ACETATE
CELLULOSE ACETATE BUTYRATE
ETHYL CELLULOSE

Poly-tint No. 3 is a hot dip dye for use at elevated temperatures. It will dye all of the above plastics.

Simple to use · Cuts production costs
Permanent colors · Will not fade

WILMINGTON
CHEMICAL CORPORATION

10 EAST 40TH STREET • NEW YORK 16, N. Y.

UNDER ONE BIG ROOF AT AUTO-LITE

Beauty AND Utility

IN PLASTICS AND METALS

Tire valve caps of flexing plastic made to seal original valve stems or stems that have had long wear.

Flexing plastic nipple for coil and wire connections. Tight, serviceable —a 100% war development.

Distributor cap, with metal insert, of advanced engineering design.

Enamel filled metal bicycle plate and plastic bicycle reflector.

Trim of outstanding beauty is made from combination of metal and plastic. An unusual product.

BUY WAR BONDS

AUTO-LITE
Decorative
METALS and PLASTICS

Look to Auto-Lite for versatility and craftsmanship in plastic, metals and combinations of both. Here at the Bay Manufacturing Division's big plant you'll find the processes, the materials, the know-how you need to add Beauty and Utility to your product. And in tomorrow's competitive market, Beauty and Utility may be the essential ingredients that spell increased sales volume for your business. Find out now what Auto-Lite can do for you by writing to

THE ELECTRIC AUTO-LITE COMPANY
Bay Manufacturing Division
DETROIT 2, MICHIGAN BAY CITY, MICHIGAN

Tune in AUTO-LITE'S GREAT RADIO SHOW "EVERYTHING FOR THE BOYS"—Starring Dick Haymes with Gordon Jenkins' Orchestra—Every Tuesday night—NBC Network

fashion note in plastics

It's a far cry from gears to glamour. And what connection is there between a steam meter case and this cunningly fashioned purse? Just this—the engineering skill that produced a five pound industrial shape in one shot, with 28 metal inserts . . also produced each separate medallion that makes this smart handbag. Plastics have strength . . beauty. utility. Watertown has the know-how and equipment to produce them. Consult engineers at The Watertown Manufacturing Company, 1000 Echo Lake Road, Watertown, Connecticut, on any plastics problem. Or check our branch office in Cleveland or our sales offices in New York, Chicago, Detroit, Milwaukee or Hawaii.

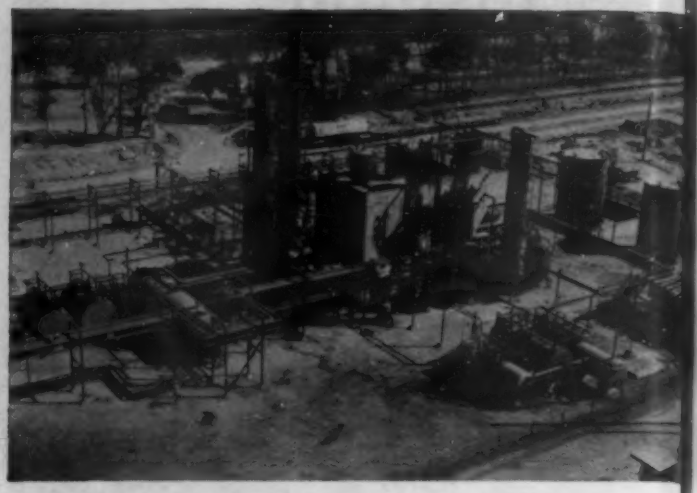
Designed by Neo Plastics Products Co.
Manufactured by Wood Flex Fashions

Watertown

A NAME AS OLD AS THE PLASTICS INDUSTRY

The PLASTICS INDUSTRY has turned over some important jobs to KOPPERS

THE LAST GOVERNMENT REPORTS show that more synthetic resins were derived from coal tar than from other sources. The bulk of the coal tar and other coal derivatives used in the plastics industry are recovered during the carbonization of coal. This is done principally in coke ovens, most of which are built by Koppers.



GREAT QUANTITIES of phenol, cresol, xylenol, benzene, styrene, solvent naphtha, and naphthalene are used in the manufacture of plastics. Many of the plants which recover these products from coke oven light oil and from coal tar were designed and built by Koppers and a number are operated by this company, as well.

TO THE CHEMIST, synthetic rubber also is a plastic. Koppers has built for the Government, and is operating for it, one of the largest plants for the manufacture of synthetic rubber chemicals. This one plant manufactured 21% of the entire nation's output of butadiene and styrene for synthetic rubber in its first year of operation.

IN THE ACTUAL CONSTRUCTION of plants for the plastics industry, Koppers has supplied many materials . . . pressure-treated timber for long-life and fire resistant construction, coal tar roofing and waterproofing materials, coal tar road paving materials, and many other products. It has also supplied coke which is used in some plastic processes.

BUY WAR BONDS AND KEEP THEM

KOPPERS

THE INDUSTRY THAT SERVES ALL INDUSTRY

So, Koppers plays a many-sided part as a supplier to the plastics industry. But Koppers is not a supplier to the plastics industry alone . . . it serves the steel, railroad, highway, chemical, aviation, construction, marine and other industries in just as varied roles. —Koppers Company, Pittsburgh 19, Pa.

THESE THREE MACHINES ARE BEING USED IN

PROCESSING DOZENS OF DIFFERENT PLASTICS

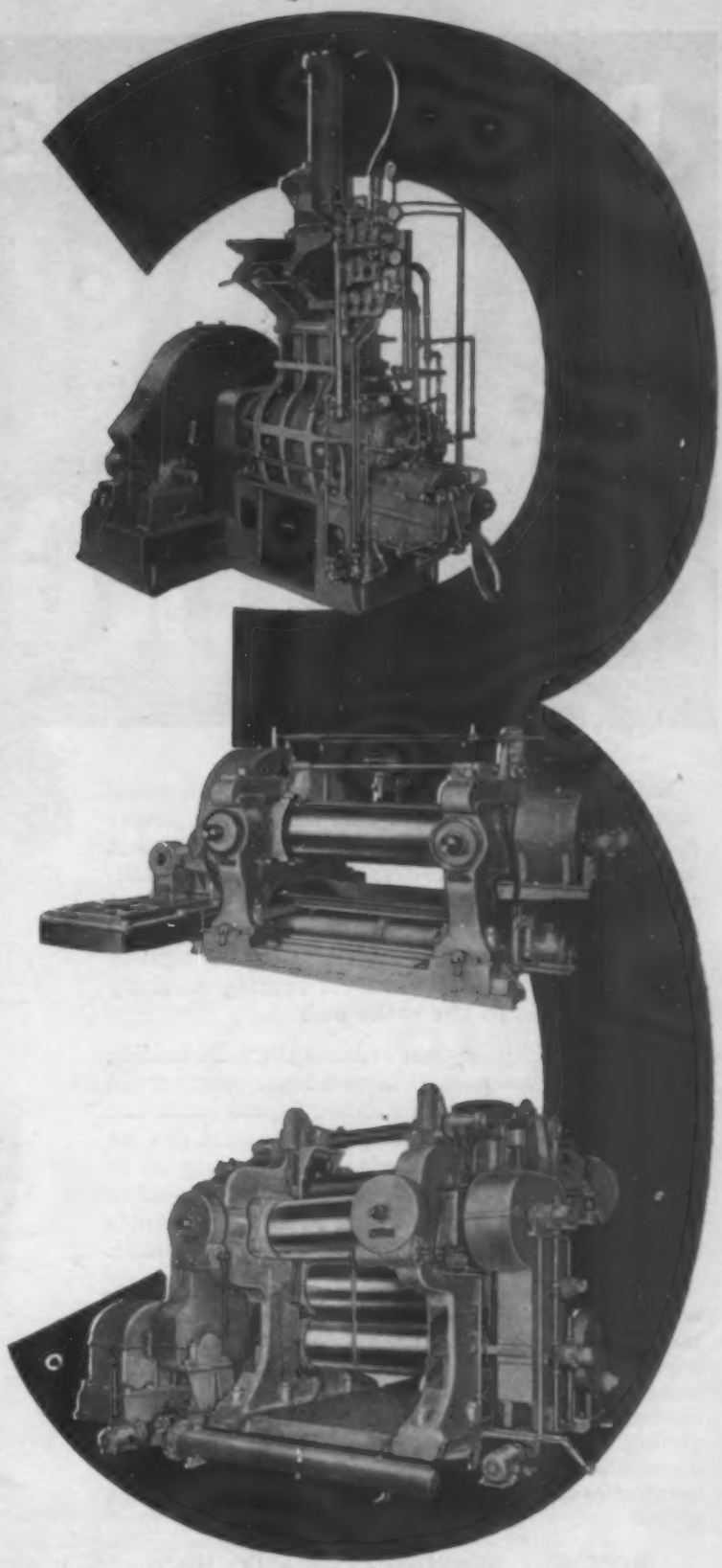
HERE ARE SOME REASONS WHY:

BANBURY MIXERS produce mixes of exceptional uniformity and superior quality, with large savings in power, labor and other costs. The heat necessary in handling plastics can be maintained at constant temperature. A wide variety of materials, colors or formulas can be processed without difficulty. Dust and fume hazards are eliminated. Positive, automatic, mechanical control of entire mixing procedure is provided.

ROLL MILLS are designed for high temperature converting and mixing, and are provided with attachments and equipment to suit individual requirements. Chamber-bored rolls, fitted with special type stuffing boxes, are carried in water-cooled, flood-lubricated journal boxes. High strength materials provide the ruggedness for heavy duty service. A patented shear pin safety device prevents breakage of housings and other parts in case of overloading. For stocks which are sensitive to contamination, the rolls can be chrome-plated and the adjustable guides and mill pan made of non-corroding metals.

CALENDERS for sheeting and coating plastics are available with any number and arrangement of rolls, and fitted with attachments to suit their particular function. Rolls are chamber-bored for high-pressure steam circulation, and are carried in full bronze-lined journal boxes, flood-lubricated by a continuous circulating oil system. Many other features also contribute to efficient operation and product quality.

Banbury Mixers, Roll Mills and Calenders are built in a wide range of sizes for either laboratory or production use. Write for further information about any of these machines.



FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.

Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Los Angeles

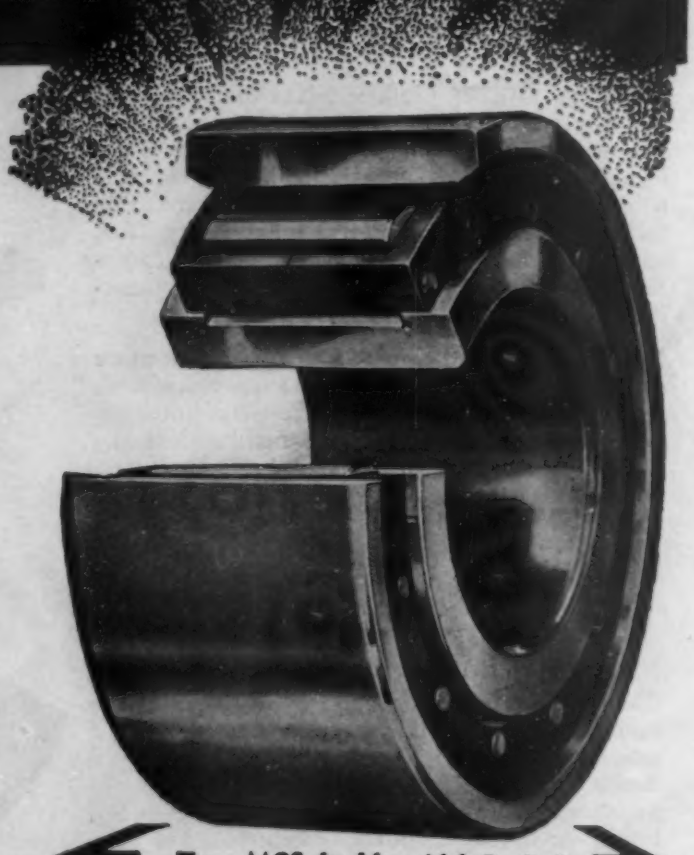
RIGHT-ANGLE LOADING REDUCES BEARING WEAR

Rollway Right-Angle Roller Bearings will make your machines *last longer* . . . with *lower power costs* . . . *lower maintenance costs* . . . and *lower replacement costs*. That's because Rollway's *right-angle loading* splits all compound loads into the two simple components of *pure radial* and *pure thrust* . . . and carries each of these components on a separate bearing assembly *at right angles to the roller axis*.

This load simplification reduces the unit loading on rollers and bearings. It insures lower starting and running torque. It holds radius-rub and roller-end wear-back to a minimum. And it eliminates all resultants from oblique loads, and all piling up of load magnitudes. Thus you get *a longer period of precision operation*. And you suffer *fewer shut-downs for bearing adjustment or replacement*.

Don't wait until reconversion problems overwhelm you. Take this important first-step toward postwar preventive maintenance today: Send drawings or detailed description of your postwar applications for free bearing analyses and recommendations by our engineering specialists. No charge. No obligation. S.A.E. and American Standard metric dimensions and tolerances are available for most applications, assuring quick supply and replacement at low cost.

ROLLWAY BEARING COMPANY, INC.
Syracuse 2, N. Y.
since 1908, makers of



Type MCS double-width Radial —carries all radial loads at right angles to the roller axis. Thrust loads are carried on a separate assembly.

ROLLWAY *Right-Angle Loaded* ROLLER BEARINGS

SALES OFFICES: Philadelphia • Boston • Pittsburgh • Youngstown • Cleveland • Detroit • Chicago • St. Paul • Houston • Tulsa • Los Angeles

HOW "NAP" WOULD HAVE APPLAUDED KYS-ITE

"Never suppose a thing can't be done." That's the stand we take—with KYS-ITE. For time and again this amazing plastic shows itself capable of filling specifications formerly considered impossible. In KYS-ITE you will find a combination of characteristics no other type of material provides. So why not let our engineers tell you if your product can be molded in KYS-ITE. Production is now being scheduled as orders are placed.

WIDE RANGE OF SHAPES

Complicated pieces with projections and depressions, large or small shapes and sections—all these and more, too, are molded successfully in KYS-ITE.

GREAT STRENGTH WITH LIGHT WEIGHT

Preformed before curing, an even impregnation of phenolic resin on interlocking fibres results in great tensile and compressive strength with an impact strength 4 to 5 times that of ordinary plastics.

INTEGRAL COLOR AND FINISH

Lustrous finish and beautiful colors are part of the material itself, hence KYS-ITE is permanently attractive. A wipe and it's bright!

KYS-ITE CAN "TAKE IT"

Unusually durable and resistant to abrasion, impervious to mild alkali and acid solutions.

NON-CONDUCTOR

KYS-ITE's dielectric properties make it invaluable where safety is a factor. Also a non-conductor of heat. Non-resonant and non-reverberating.

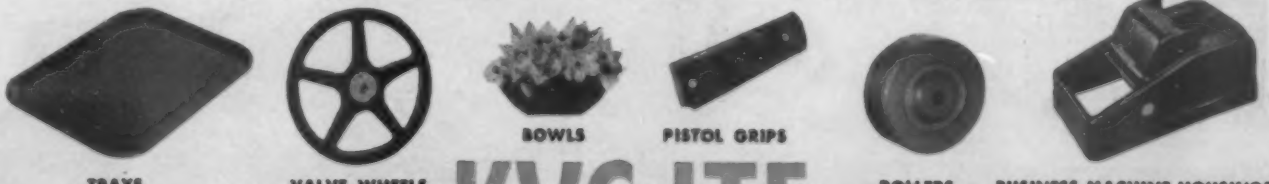
Have you any questions on plastics? Just get in touch with Keyes Service Department. You'll receive information on the latest developments in the field. If we can't fill your needs in plastics, we'll let you know what companies most probably can.

Buy War Bonds—and Keep Them

KEYES FIBRE COMPANY
420 Lexington Avenue
New York 17, New York
Plant at Waterville, Maine

KEYES
MOLDED PRODUCTS

KYS-ITE articles indicating the range of items we mold to specifications and deliver complete, ready for use.



The Long-Fibred Wood Pulp Filled Phenolic

KYS-ITE

Trademark Reg. U. S. Pat. Off.

Resin Plastic Pre-formed Before Curing

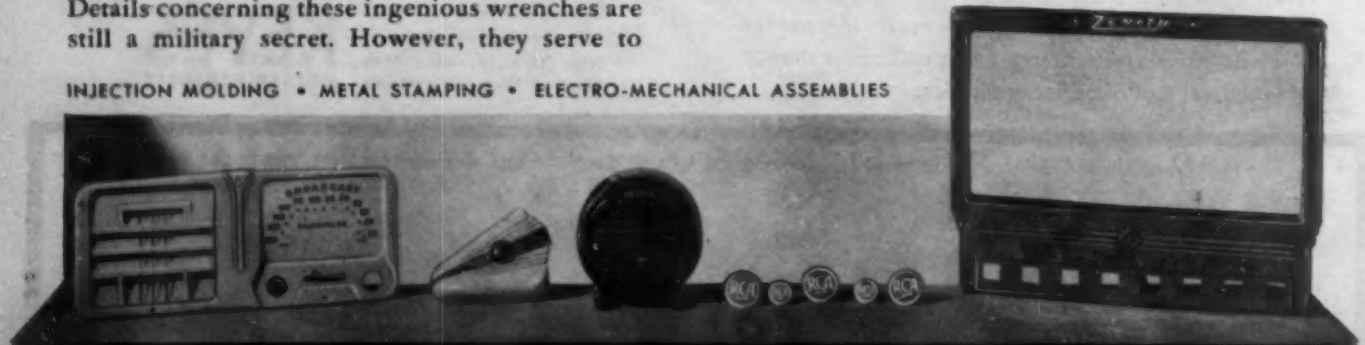
SPECIALISTS IN METAL REINFORCED THERMOPLASTICS

Santay
SYMBOL OF PRECISION CRAFTSMANSHIP

TWO WRENCHES ALL IN ONE! . . precision made from TWO materials . . thermoplastics reinforced with steel inserts. Here again Santay engineers have pioneered in producing this combination wrench from thermoplastics *for the first time!* Ample savings in metal and weight were effected . . worthwhile contributions to our war effort.

Details concerning these ingenious wrenches are still a military secret. However, they serve to demonstrate again, the successful application of *metal reinforced thermoplastics . . a highly developed SANTAY specialty!* Think of Santay's precision craftsmanship whenever a thermoplastic problem is involved. Let our capable engineers suggest how you can best make use of speedy, economical injection molding.

INJECTION MOLDING • METAL STAMPING • ELECTRO-MECHANICAL ASSEMBLIES



SANTAY CORPORATION 351-359 N. CRAWFORD AVE., CHICAGO 24, ILLINOIS

FORMERLY SINKO TOOL & MANUFACTURING CO.

REPRESENTATIVES: POTTER & DUGAN, INC., 29 WILKESON STREET, BUFFALO 2, NEW YORK • PAUL SEILER, 7779 CORTLAND AVENUE, DETROIT 4, MICHIGAN • QUEISSER BROS., 108 E. NINTH STREET, INDIANAPOLIS 2, INDIANA

Plexiglas

CHOSEN FOR NAVY FLASHLIGHT LENS

THE answer to the Navy's need for a flashlight to withstand salt air, salt spray and even immersion in water is the new all-plastic, water-tight model equipped with a molded PLEXIGLAS lens.

PLEXIGLAS was selected for the lens because this acrylic plastic meets all requirements for moisture and chemical resistance and light transmission. PLEXIGLAS is permanently transparent, light in weight and practically unbreakable.

The mounting threads are integral with the lens—molded in the same efficient cycle—eliminating assembly operations and reducing the possibility of leakage.

Perhaps PLEXIGLAS can improve the appearance, serviceability and efficiency of your product. Call or write our nearest office: Philadelphia, Los Angeles, Detroit, Chicago, Cleveland, New York. Canadian Distributor: Hobbs Glass Ltd., Montreal.

Molded for Delta Electric Co., Marion, Ind., and Fulton Manufacturing Co., Wauseon, Ohio, by The Metal Specialty Co., Sobenite, Inc., and Reynolds Molded Plastic Division of Continental Can Co.

Only Rohm & Haas makes

PLEXIGLAS

CRYSTAL-CLEAR ACRYLIC SHEETS AND MOLDING POWDERS*

*Formerly CRYSTALITE Molding Powders

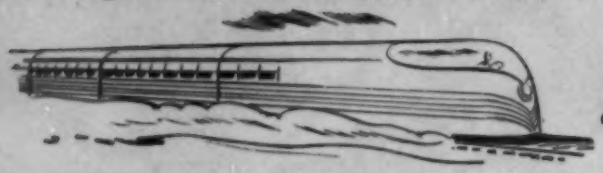
PLEXIGLAS is the trade-mark, Reg. U.S. Pat. Off., for the acrylic resin thermoplastic sheets and molding powders manufactured by Rohm & Haas Company.
Represented by Cia. Rohm y Haas, S.R.L., Carlos Pellegrini 331, Buenos Aires, Argentina, and agents in principal South American cities.

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Manufacturers of Chemicals including Plastics . . . Synthetic Insecticides . . . Fungicides . . . Enzymes . . . Chemicals for the Leather, Textile and other Industries

NO "DOCTORED-UP" VERSION OF AN OLD IDEA . . IT'S A



20TH CENTURY DESIGN THAT TOOK YEARS OF RESEARCH

AND TESTING TO DEVELOP!

IT'S PHILLIPS → THE ENGINEERED RECESS

In ease and speed of driving, there is nothing quite like the Phillips Recessed Head Screw.

That's because the Phillips Recess was developed from scratch–not just adapted from some older, less satisfactory type of recess. It's an *engineered* recess . . . with years of costly testing and research behind each design feature.

As a result, every angle, every flat plane, every dimension of the Phillips Recess makes a definite contribution to easier, faster, more efficient screw driving.

The recess walls are angled just right to eliminate fumbling starts, to let workers utilize their *full* turning power. The 16 flat planes are provided to hold even worn drivers snugly. And the depth of the recess is exactly figured to give unusual strength to Phillips Screw Heads, and make it easy to keep Phillips Bits and Drivers lined up with the axis of the screw.

To Make Wartime Quotas and Peacetime Profits . . . get the faster starting – faster driving–stronger, better-looking fastenings that only screws with Phillips Recessed Heads can give you! All over the country, manufacturers are switching to Phillips Recessed Head Screws to speed up assembly and cut costs. Give your assembly department "a shot in the arm" – change to Phillips Screws, too. Available in all head styles, types, and sizes!

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS • SELF-TAPPING SCREWS • STOVE BOLTS

IDENTIFY IT!

Center corners of Phillips Recess are rounded . . .
NOT square.

Bottom of Phillips Recess is nearly flat . . .
NOT tapered to a sharp point.

24 SOURCES

American Screw Co., Providence, R. I.
Atlantic Screw Works, Hartford, Conn.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
General Screw Mfg. Co., Chicago, Ill.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
Manufacturers Screw Products, Chicago, Ill.
Milford Rivet and Machine Co., Milford, Conn.
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Wolverine Bolt Co., Detroit, Mich.

PLASTICS
On the past year we have produced thousands of different precision plastic parts to the most critical print specifications.
Our record of less than 1/2 of 1% rejects amplifies our technical ability in the field of Injection, Compression, Transfer Molding and Custom Fabrication.
For your tough plastics problem
Call us!

CLEAR OUT THE "Fastening Bugs" BEFORE YOU SET UP FOR PEACETIME PRODUCTS

Specify the SHORT CUT FASTENING METHOD and avoid later changes, expense, delays

Don't wait until you resume manufacture of your peacetime product to find out that needless tapping, needless inserts in plastics, or other fastening "bugs" are slowing down assemblies and running up your costs.

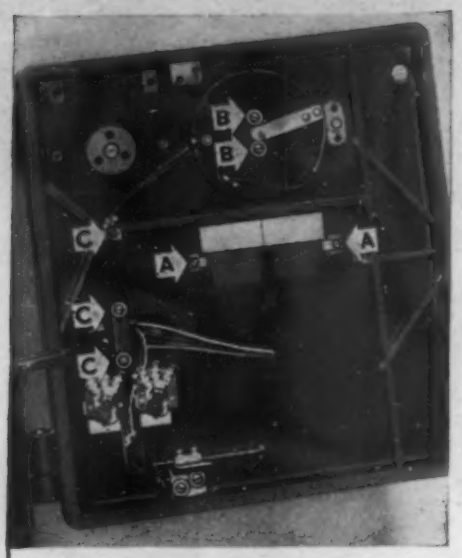
Check up *now*, while your plans are still in process. Choose fastenings as carefully as you settle any other factor of design. Make sure you are using the *short cut fastening method* – Parker-Kalon Self-tapping Screws – wherever possible.

Give your product the advantage of the 30% to 50% saving in assembly time and labor made possible by P-K Self-tapping Screws. Eliminate tapping for machine screws and tap expense – fumbling with nuts and bolts – costly inserts that slow up molding.

USER'S GUIDE – FREE! P-K "Users' Guide" describes all types of Parker-Kalon Self-tapping Screws and tells where to use them. Designers and assembly planners need this important information. Write for a copy.

ASK THIS EXPERT ON FASTENINGS

how to simplify and strengthen assemblies, how to save time and lower costs. The P-K Assembly Engineer gives you unbiased advice, because P-K makes all types of Self-tapping Screws. Ask him to call . . . or, mail assembly details for recommendations. Parker-Kalon Corp., 208 Varick Street, New York 14, N. Y.



Will "Blind Fastenings" boost your parts breakage?

Heres' how Tagliabue licked this "bug" and speeded production

Difficulty in judging hole depth, when tapping blind holes for small machine screws, resulted in taps breaking through, ruining plastic parts at Tagliabue Mfg. Co., Brooklyn, N. Y., makers of TAG pressure and temperature instruments.

Changeover to P-K Self-tapping Screws ended this trouble, stopped breakage, saved tapping time and tap expense.

P-K Type "Z" Screws are used (A) to attach steel clips fastening window to plastic door; (B) to fasten plastic rheostat disc to door; (C) to attach steel clamps holding wire to door. The screws form their own strong threads as they are turned into plain holes. One easy operation makes a fastening.

PARKER-KALON
Quality-Controlled
SELF-TAPPING SCREWS

For Every Metal and Plastic Assembly

DU PONT FORMALDEHYDE

U.S.P. Solution for Plastics Manufacture

YOU can depend upon the quality because every pound of Du Pont Formaldehyde is produced under strict control and supervision. This Du Pont product is designed to meet the production requirements of the plastics manufacturers. Consider its advantages.

UNIFORM STRENGTH—Removes uncertainty regarding yields and quality of the finished plastic products.

HIGH PURITY—Finished plastics of high purity require high purity raw materials.

WATER-WHITE COLOR—Light-colored or white finished products can be made only from water-white raw materials.

LOW ACIDITY—Reduces corrosion of apparatus; permits easier control of the reaction.

Shipment made in tank cars and tank trucks or in modern containers from adequate stocks carried in principal cities.

Also available: Paraformaldehyde . . . powdered or granular, minimum strength 95%; Hexamethylenetetramine . . . U.S.P. crystals and technical. Information and technical assistance on the use and handling of these materials are available from the Electrochemicals Dept., E. I. du Pont de Nemours & Co. (Inc.), Wilmington, Del.

LET'S ALL BACK THE ATTACK!

AVAILABILITY

Small orders can be filled without WPB application

Formaldehyde and Paraformaldehyde are under General Allocation Order M-300 as appendix A materials subject to Schedule 9; Hexamethylenetetramine is covered by Section 10. The order permits purchases under "Small Order Exemption" of quantities up to 10,000 lb. of Formaldehyde, 3,000 lb. of Paraformaldehyde and 10,000 lb. of Hexamethylentetramine in any calendar month. These quantities can be obtained without application. Quantities in excess of the above still require application on Form WPM-2945 (PD-600).

DU PONT ELECTROCHEMICALS

DU PONT

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

your
WAR PLASTICS
will soon
be looking for
a new Job!
CERTIFIED MERCHANDISE
UNITED STATES TESTING CO. INC.
SEAL OF QUALITY
When your Plastics switch from planes, trench mortar fuses, helmet liners, and the many other war products to food containers, furniture, plumbing, and the thousands of new civilian uses...will they be fit for the job? ★ Now is the time to find out! ★ Submit your Plastics to Scientific Test...learn their physical, chemical, and electrical properties...find out whether they meet the requirements of the civilian uses you are planning...determine whether changes must be made for postwar application. ★ At the United States Testing Company, Inc., a special series of Plastic Tests will answer any question...will solve any problem... regarding your Plastics and their practical application.
Write for price list of Tests, now.
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COLUMBIAN COLLOIDS

Mapico PIGMENTS ARE PERMANENT

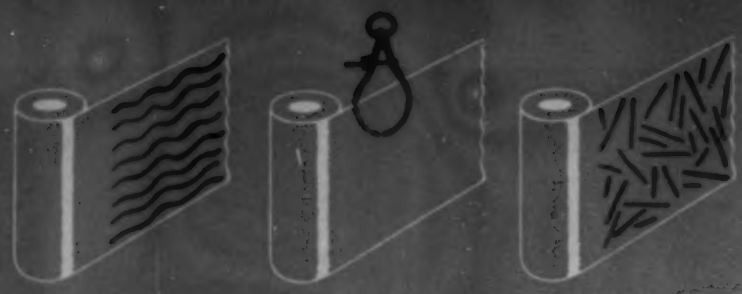
YELLOWS
•
REDS
•
BROWNS
•
BLACKS

CHEMICAL inertness and stability are among the characteristics of Mapico pigments which give them high value as coloring agents for all types of plastics. They produce desired shades with minimum pigmentation. In addition Mapico pigments have exceptional resistance to color change.

We invite technical inquiry

COLUMBIAN CARBON CO. • **BINNEY & SMITH CO.**

MANUFACTURER — DISTRIBUTOR



MANUFACTURERS OF PRECISION-MADE PULP AND PAPERS FOR MORE THAN FORTY YEARS

MUNISING PAPER

PRECISION-MADE PULP AND PAPERS FOR THE PLASTICS INDUSTRY:

SUBJECT: IMPREGNATING AND COATING BASE STOCKS

The Munising Paper Company manufacturers RESIN IMPREGNATING and COATING BASE STOCKS to specification for the plastics industry. Individual requirements of each customer are carefully considered and each run is controlled to meet these requirements.

Two general types of paper are made with the following characteristics:

Grade	Characteristics
Saturating Papers	-High and uniform absorbency; -Strength in aqueous and non-aqueous solvents; -Low density; -Uniform caliper; -Uniform formation.
Coating Base Stocks	-Controlled resistance to solvent penetration; -High density; -Uniform surface structure; -Uniform formation.

Should the grades and characteristics mentioned above be of interest, may we suggest you contact us.

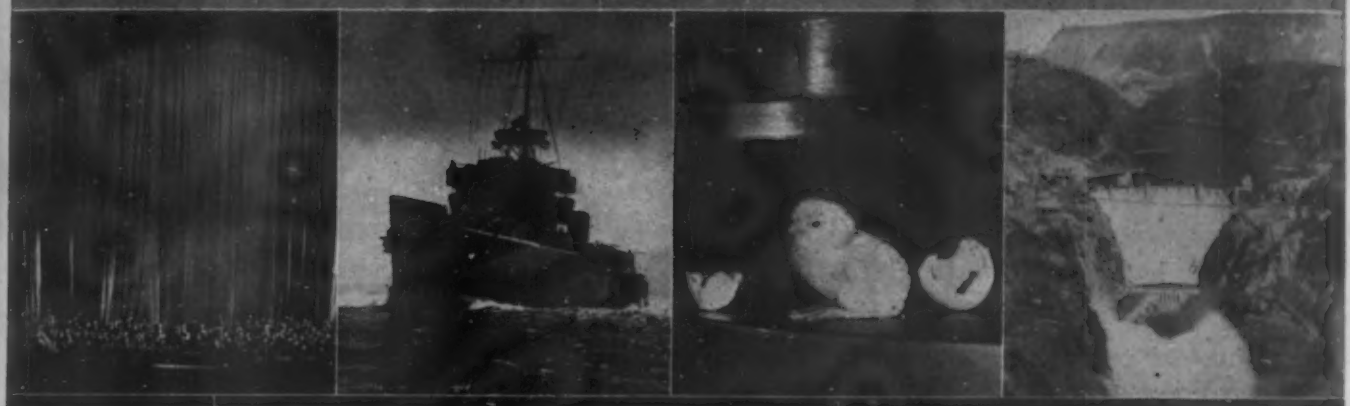
THE MUNISING PAPER COMPANY

THE MUNISING PAPER COMPANY

Sales and Executive Offices:
135 S. LaSalle St., Chicago 3, Illinois

Pulp and Paper Mills
Munising, Michigan

Would you believe it?



BALDWIN supplied the hydraulic elevators that raise and lower the stage of Radio City Music Hall.

BALDWIN diesel engines are used for main propulsion units on minesweepers and for auxiliary power on many other vessels.

BALDWIN testing machine of 3,000,000 pounds capacity can be controlled so as to break the shell of a hatching egg without harming the chick.

BALDWIN hydraulic turbines, 115,000 horsepower capacity, driving huge electric power generators, are installed at Boulder Dam.

Baldwin manufactures a wide diversity of products, including testing equipment for wind tunnels, steering gears for LST landing craft, hydraulic elevators for aircraft carriers, and many other machines and instruments, serving industry on which America is depending to speed final victory.

Of course, Baldwin is well known as the builder of locomotives of all types—steam, diesel-electric and electric—doing their share of the greatest transportation job in history.

BALDWIN

BLW THE BALDWIN GROUP

The Baldwin Locomotive Works, Philadelphia, Pennsylvania: Locomotive & Ordnance Division; Baldwin Southwark Division; Cramp Brass and Iron Foundries Division; Standard Steel Works Division; The Whitcomb Locomotive Co.; The Pelton Water Wheel Co.; The Midvale Co.

New plastic products for better living will come out of this war — and 1945, more than ever before, will be a plastic year.

Our production, now entirely devoted to war needs, will be converted at the peace to fabrication of many new applications of plexiglas, lucite and other plastics, such as the radio cabinet pictured above.

Come to **dura** with your ideas for postwar plastic fabricating; our experience, personnel and "know-how" are at your service to plan and produce new things efficiently and economically to make this a better world.

CONSULT DURA FIRST

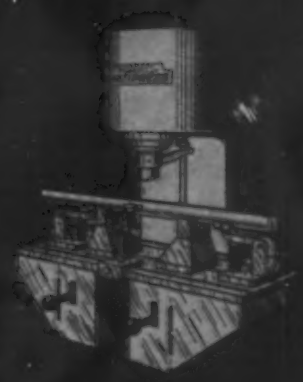
dura plastics, inc.

1 west 34 street. new york 1, n. y.

Custom fabricating specialists to the aviation, electronic and shipbuilding industries.

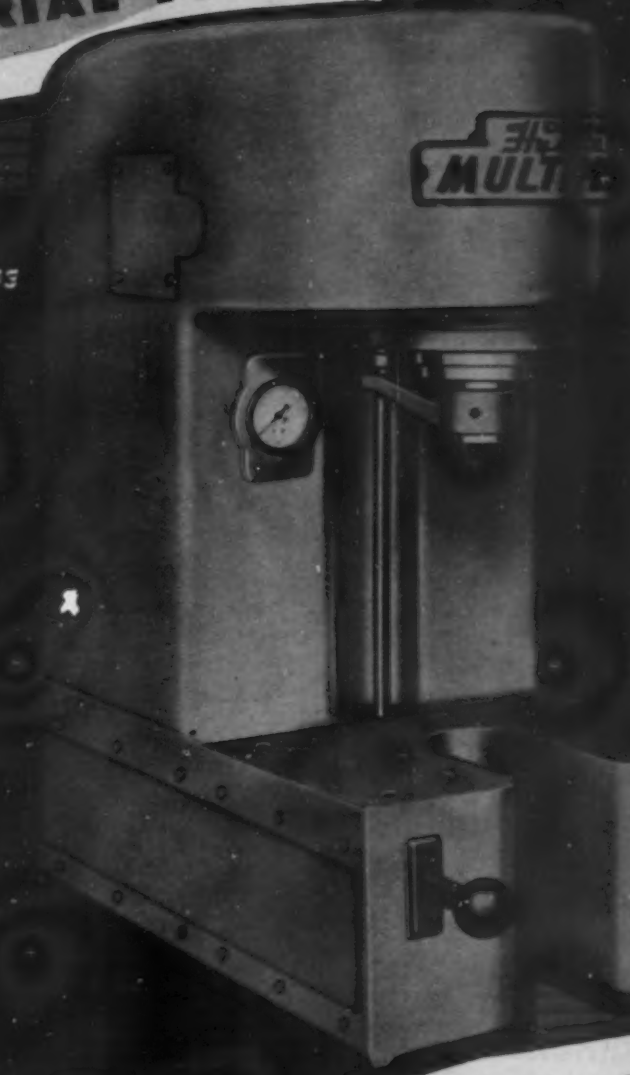
Announcing MULTIPRESS

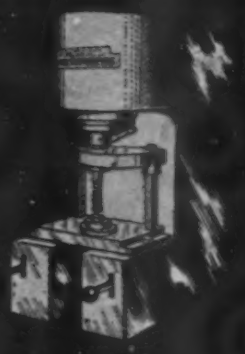
AN ENTIRELY NEW KIND OF INDUSTRIAL TOOL



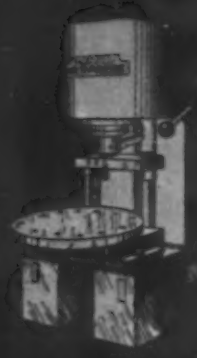
With Straightening Fixtures

With Honing Fixtures

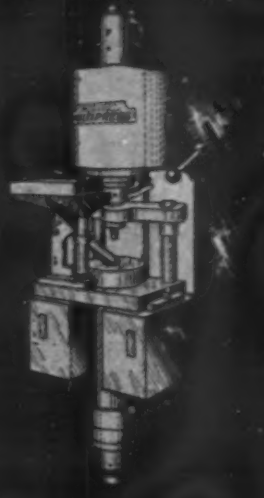




With Broaching Attachment



Showing Dial-Type Feed



Equipped for Automatic Pelleting

With Motor Driven Indexing Table

For Scores of Production Jobs

A 4-ton production giant in midget form . . . a completely self-contained, bench-size, oil-hydraulic machine tool of amazing scope. MULTIPRESS delivers downward ram pressures of from 300 to 8,000 pounds . . . upward pressures to 5,000 pounds . . . in strokes which may be regulated from 6 inches to 1/16-inch . . . at ram speeds up to 200 inches per minute downward, and 300 upward! Its work-table measures 10½ x 16 inches without extensions. The opening between ram and table is 11 inches. In addition, there are fixtures and attachments for MULTIPRESS which fit it for almost every type of operation requiring pressure . . . sustained, in repeat strokes, synchronized with indexing tables, in single or automatically repeated cycles, and many other ways! Write today for details on this new HydrOILic tool of multiple uses!

Basic Unit **$575.00** f.o.b. Col's.

The Denison Engineering Company

1176 Dublin Road, Columbus 16, Ohio

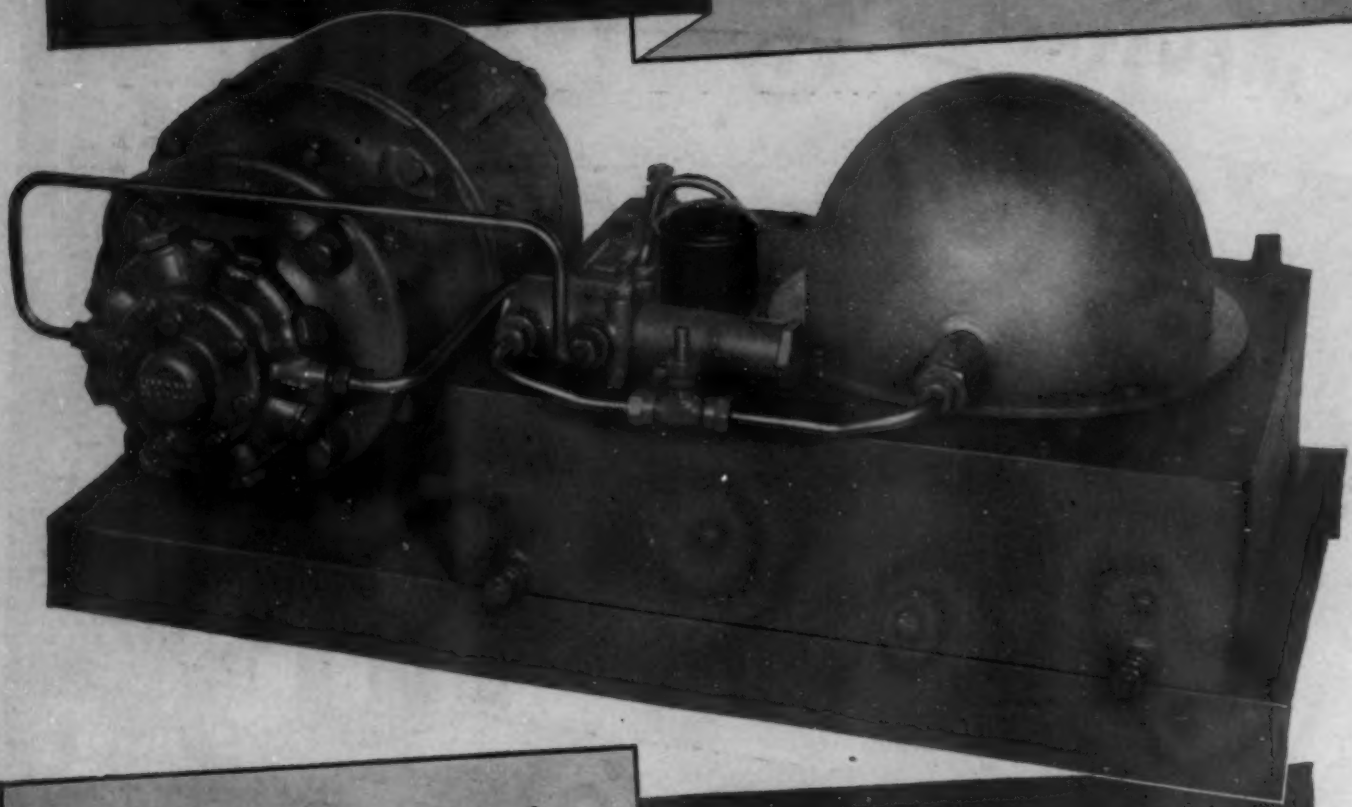
DENISON EQUIPMENT for APPLIED HydrOILics

HydrOILics INDUSTRY'S RIGHT HAND

HYCON

3000 p.s.i. Hydraulic Power Unit

3 HP Motor
8 cylinder Pump
Unloading Valve
Accumulator and Reservoir



A small compact unit for machine tools, hydraulic presses and test equipment

Quickly and easily installed for smooth reliable hydraulic operations up to 3000 p.s.i.

Specifications and Engineering Data on Request

THE NEW YORK AIR BRAKE COMPANY

Hydraulic Division

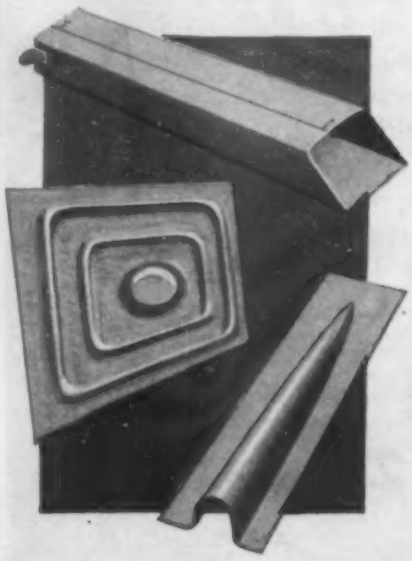
420 Lexington Avenue, New York 17, N. Y. Factories: Watertown, N. Y.

BAKELITE

TRADE-MARK

THE EARTH WAS FLAT *ONCE!*

At least, for thousands of years people *thought* the earth was flat. Likewise, it is *now* generally thought that flat laminated sheet stock must remain flat, no matter how machined or manipulated. But science proved the earth a sphere, and recent developments have shown that flat stock can readily be "postformed" — with curves and compound curves for a wide variety of practical purposes.



The fact is, that, conventional flat laminated sheets, when impregnated with BAKELITE laminating varnishes, and heated to a sufficiently high temperature, have a very useful measure of residual thermoelasticity. A simple postforming technique has been developed for turning this characteristic to account—first, by a heat-softening process, and then by pressure-forming in a cold die. Calling only for inexpensive tools and the standard methods associated with metal working, postforming speeds up production and brings substantial die cost savings. The finished products are lightweight, structurally stable, and endowed with high mechanical strength.

The postforming of flat laminated sheets creates a wealth of opportunities for new and improved product designs. Further information about the postforming technique and its range of possibilities will be sent you gladly upon request. Write Department 15.

TRADE MARK

BAKELITE CORPORATION

Unit of Union Carbide and Carbon Corporation

UCC

30 EAST 42ND STREET, NEW YORK 17, N.Y.

PLASTICS

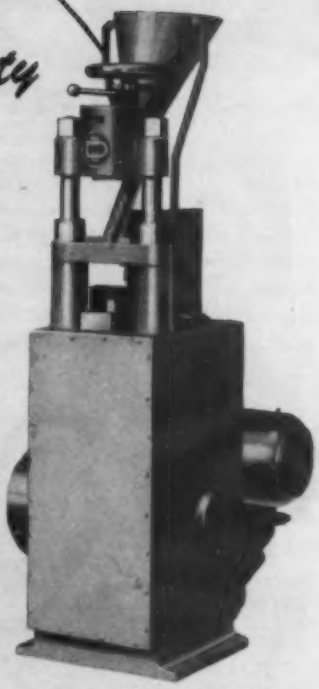
PLASTIC PREFORMS

at High Speed with Uniformity

★ Start your plastic pill production *right*—for *today and tomorrow*—with Defiance Plastic Preforming Machines! Highly versatile—these machines designed to produce tablets in a *wide variety of shapes and sizes* to meet growing demands for plastics. Weights of preforms can be rapidly changed—without even stopping the machines. Tools can be quickly interchanged.

Cleanliness in operation assured with material leakage reduced to a minimum. Easy to change colors. Less "down time" for cleaning. Exclusive features of Defiance design mean *greater uniformity in weight and density*—with high speed production—and utmost dependability. Write for more facts. Defiance Machine Works, Inc., Defiance, Ohio.

No. 20—*for large pills and wide range of shapes and sizes; withstands 100-ton preforming load.*

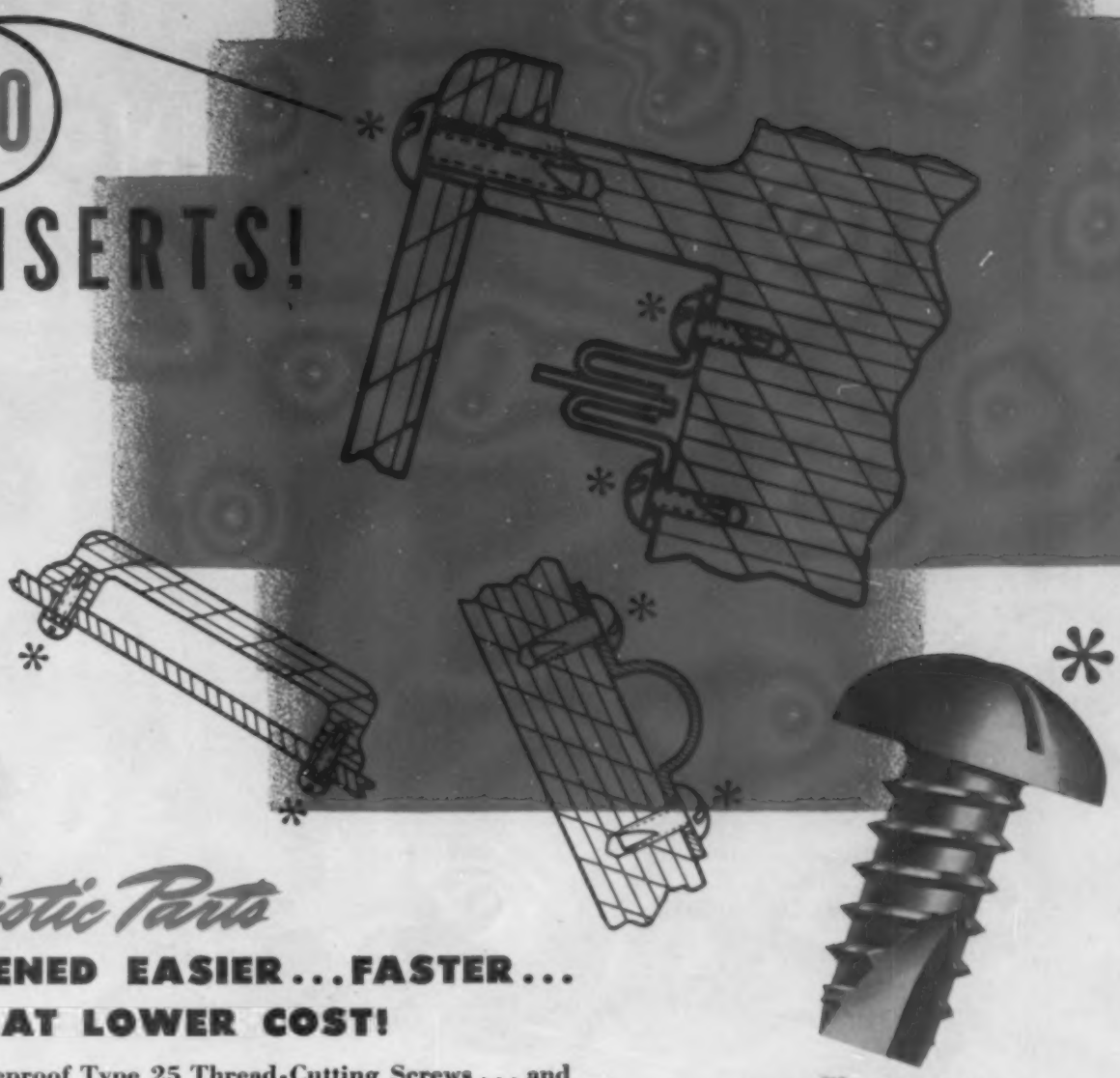


No. 10—*primarily for cylindrical shapes, either solid or perforated; withstands 25-ton preforming load.*

DEFIANCE

Plastic Preforming Presses

NO INSERTS!



Plastic Parts

FASTENED EASIER...FASTER... AND AT LOWER COST!

Use Shakeproof Type 25 Thread-Cutting Screws . . . and you need no inserts! That's because the Type 25 cuts its own thread as you drive it.

Specially designed for plastics, this screw can be easily adapted for use in your product. Shakeproof engineers can advise you of the best methods for assembly. Their experience and thorough knowledge of fastening techniques make them well qualified to give you such counsel. This service plus the research facilities of the Shakeproof laboratories are yours for the asking.

Improve product performance! Speed assembly! Eliminate unnecessary parts! Reduce production costs! All this *can* be done with Shakeproof Type 25 Thread-Cutting Screws. Write today for complete information.

SHAKEPROOF

TYPE 25

THREAD-CUTTING SCREWS

- Cut their own threads in all types of plastics.
- Eliminate inserts, taps and tapping operations
- Strong, tight fastening always certain
- Save vital man-hours—speed up production

SHAKEPROOF inc.

Fastening Headquarters

Distributor of Shakeproof Products Manufactured by ILLINOIS TOOL WORKS

2501 North Keeler Avenue, Chicago 39, Illinois

Plants at Chicago and Elgin, Illinois

In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario

Los Angeles Office
8870 Wilshire Blvd., Los Angeles 36, Cal.

Detroit Office
2985 E. Grand Blvd., Detroit 2, Mich.

***Free* TEST KIT!**

Contains a variety of Shakeproof Type 25 Thread-Cutting Screws in various styles and sizes. Write today for free test kit No. 10.

Other Shakeproof Products:

Shakeproof Lock Washers *with Exclusive Tapered-Twisted Teeth;* Shakeproof Type 1 Thread-Cutting Screws *for metals;* Sems Fastener Units *Pre-Assembled Shakeproof Lock Washer and Screw;* Shakeproof Quick Fasteners *for immediate opening and locking.*

PRECISION

Starts here

Here is where efficient plastic production starts, at the drawing board. Here models are developed, the right plastics chosen, the "bugs" eliminated. It is at this point that Precision Plastics Company can start being of real service to anyone interested in the manufacture of plastic parts or products. After the smoke of battle clears away, remember the name "PRECISION," where skilled craftsmen, modern facilities, and practical experience are combined with *personal service*.

PPC

PRECISION *Plastics Company*

1724 W. INDIANA AVE., PHILADELPHIA 32, PA.

VELON* stands for Color, Durability, Cleanability, Versatility

Where can you use a fabric? What would you use it for? What must it be like?

Must it wear better than any you've ever dreamed of? Well, after three years of rugged wartime service as upholstery material in thousands of public vehicles, *Velon* has yet to show signs of wear.

Must it be waterproof? *Velon* is virtually 100% non-absorbent. Must it be grease-proof? Must it be resistant to acids and alkalis? Must it be non-inflammable? That's *Velon* on every count.

Must it be practical in any color—even light pastel shades? *Velon* is—because it's so easy to clean. You simply wipe *Velon* with a cloth dampened in water or cleaning fluid—and it's clean as new. Moreover, *Velon* will not fade.

Must it be adaptable, versatile? Frankly, we don't know ourselves the number of places where *Velon* will eventually be used. It can be made in endless textures, colors, weights, weaves and patterns.

Most *Velon* now goes for victory needs. But we'll be glad to discuss with you the practical applications it may have to your product in the near future. Or to work out new forms of this amazing material to fit your own particular requirements in any of the products to which *Velon* is applicable.

FOR THE BEST IN MUSIC, LISTEN TO THE VOICE OF FIRESTONE MONDAY EVENINGS OVER THE ENTIRE NBC NETWORK.

ANOTHER CONTRIBUTION TO A BETTER WAY OF LIFE by

Firestone

*Trademark—Pronounced VEL-LON

HOW DO YOU SELECT A MOLDER?

Do you use the hat-pin system—just put a hat pin through the nearest directory? Do you select your molder by his looks?

You probably don't do either. You probably look for a molder who can give you some help in selecting a material. One who can design a decent mold. One who can mold your parts to fit your blueprints and meet your schedules.

We think we can fill those requirements. We also have the additional selling point of 3 complete and separately located plants to handle large national or small local orders. Our name is Mack Molding Company. Our plants are located at Wayne, New Jersey; Arlington, Vermont; Waterloo, P. Q., Canada.

Mack

MOLDED

EXCELLENCE

SALES OFFICES: NEW YORK CITY, CHICAGO DETROIT, INDIANAPOLIS BOSTON ST. LOUIS

PILOT YOUR PRODUCTS TO PROFITABLE MARKETS WITH MOSINEE *Paperology*

Many a product is being piloted "on the beam" to bigger and better market opportunities with Mosinee Paperology "at the controls". In much of the same manner that metallurgists create alloys resistant to acid, rust, stain or corrosion . . . alloys of specified hardness, toughness, pliability, density, spring, weight, color, etc... Mosinee Paperologists develop "special analysis" papers to meet a wide variety of industrial product and packaging requirements.

Scientifically engineered Mosinee is taking the place of other materials previously considered "essential" in electrical products.

The success of many plastics depends upon paper made to a specific formula with positive control of chemical and physical properties. Products and parts made of Mosinee frequently represent improved quality and utility. Costs are reduced . . . markets expanded.

Mosinee can be engineered to work better in your processing machines or packaging equipment . . . minimizing delays, work-stoppages and manpower losses, reducing maintenance costs, lowering production costs and boosting output.

Mosinee Paperologists are ready to work on your present or postwar problems.

MOSINEE PAPER MILLS CO. MOSINEE WISCONSIN

Please address your letter "Attention Dept. A"

MOSINEE PAPER MILLS COMPANY
MOSINEE • WISCONSIN

Essential Paper Makers

New STOKES 50-Ton Hydraulic

Completely Automatic Press

- **LARGER PIECES**
- **MORE PIECES**
- **HIGH SPEED OPERATION**

100% Automatic

Model 236

Patent

OUTSTANDING FEATURES

Automatic Cycle Controller, the "brain" of the machine, for split-second timing of every machine operation — proved in hundreds of Stokes Completely Automatic Presses in the country's leading molding plants. Cycles have been reduced as much as 50% or more. Human errors are eliminated. Every piece is identically molded.

Super-Sensitive Trap or checking device — sensitive to the fraction of a gram. The "heart" of the machine that checks every molded piece made. Failure to eject — lack of material — or any other irregularity stops press instantly. The pieces literally "run the press." The only proved and foolproof method of operating a Completely Automatic Machine.

Multiple Feed with micrometer adjustment. Capacity up to 48 cu. in.

High Speed Operation. Opening and closing at the rate of 100 in. per min. with controlled final compression speed adjustable to the flow characteristics of the molding material.

One Man Operates a Score of Presses. Completely Automatic, this press requires only a minimum of molding labor. Once set up, one man can attend a large battery of presses as only attention required is to keep hoppers filled and to remove accumulation of molded pieces.

Low Power Requirement. Only 2 hp. motor required to develop full 50 tons press capacity.

Self-Contained, Self-Sufficient. Electrically powered and heated. Requires only electrical and compressed air connections.

Write for Complete Information

F. J. STOKES MACHINE CO.
5934 Tabor Road Philadelphia 20, Pa.

F.J.Stokes MOLDING EQUIPMENT

FJS Est. 1895

ASSIGNMENT WANTED

American industry has amply demonstrated its ability to make available to most people the benefits of man's creativeness for better living in a world at peace . . . It is in connection with this universal desire by industry to improve its products and manufacturing methods that P-G wants assignments NOW for the making of plastic parts and products . . . You will find P-G engineering experience, designing skill, and precision production facilities ready TODAY to meet your most exacting specifications . . . If your part or product presents exceptional manufacturing problems or requires close tolerances, consult us!

PRECISION FABRICATORS OF PLASTICS FOR INDUSTRY

PLASTI-GLO MANUFACTURING CO.

1832 IRVING PARK ROAD, CHICAGO 13, ILL.

Plasti-Glo FABRICATORS

Copyright 1944, Plasti-Glo Mfg. Co.

PLASTIC WINGS

FOR THE HUMAN VOICE

Two-way radio communication will speed and safeguard postwar traffic . . . in the air, over the rails, and on the road. For just such rugged applications, this microphone has been engineered to operate with peak efficiency. It separates the human voice from the roar of aircraft engines or driving locomotives . . . and speeds the spoken words clear and loud. This microphone is the product of Electro-Voice Corporation, South Bend, Ind. Molded parts are furnished by Molded Products Co.

Consider how much was contributed to the design of this instrument by the skillful use of plastics. The housing furnishes both sturdy armor and intricate structural support for the delicate mechanism. At the same time, it provides sleek, streamlined beauty and agreeable smooth warmth of touch. The high impact phenolic used is capable of withstanding more than 10,000 drops. Yet it is light. The completed microphone weighs less than eight ounces.

The plastic components for the interior construction are models of the molder's art. Notice their complicated design with numerous side holes. Countersunk holes for self-tapping assembly screws are molded in. Dimensional accuracy and electrical stability are held to extreme limits in the molding process.

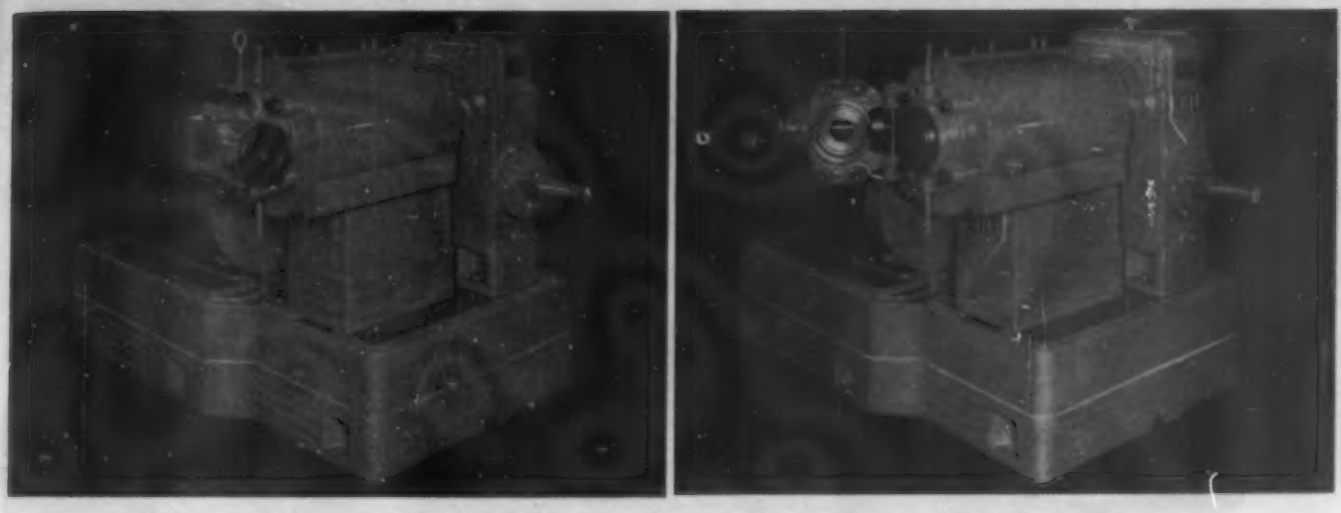
Both the design and fabrication of the molds for these parts required a good deal of ingenuity and skill. Turning out the parts in quantity calls for production "know-how." Such is the service we offer for the design or improvement of your product. Send us your specifications for quotation, or ask one of our engineers to consult with you.

* * * *

MOLDED PRODUCTS COMPANY,
4533 W. Harrison St., Chicago 24, Ill.

PLASTICS DIVISION

MOLDED PRODUCTS



NO. 2 ROYLE PLASTICS INSULATING MACHINE

BUILT FOR YEARS OF SERVICE

Recently we received an inquiry from a customer who wanted to know if certain alterations could be made to his tubing machine. A check of our records revealed that the machine in question was delivered over fifty-one years ago—in July 1893.

It is encouraging to know that in these days of "use it up, wear it out" there are Royle oldtimers still capable of doing their bit on the Production Front.

Today, as always, our skills are devoted to designing and building continuous extrusion machines to meet the specific requirements of the application involved.

JOHN ROYLE & SONS

ROYLE
PATERSON
N. J.

PIONEER BUILDERS OF EXTRUSION MACHINES SINCE 1880

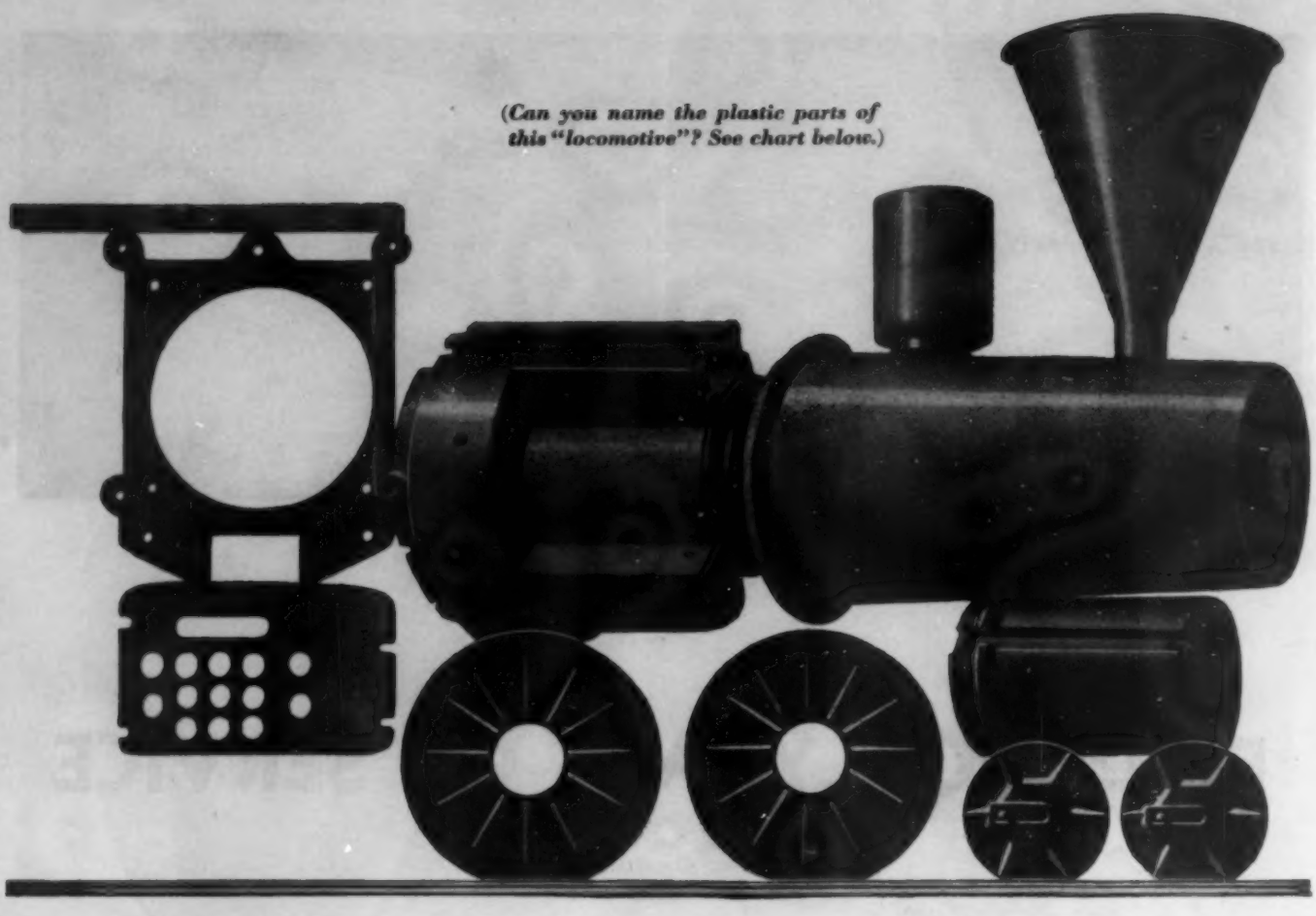
Continental Europe
James Day (Machinery) Ltd.
London, England

Home Office
B. H. Davis J. W. VanRiper
Sherwood 2-8282

Akron, Ohio
J. C. Clinefelter
University 3726

PATERSON 3, NEW JERSEY

(Can you name the plastic parts of this "locomotive"? See chart below.)



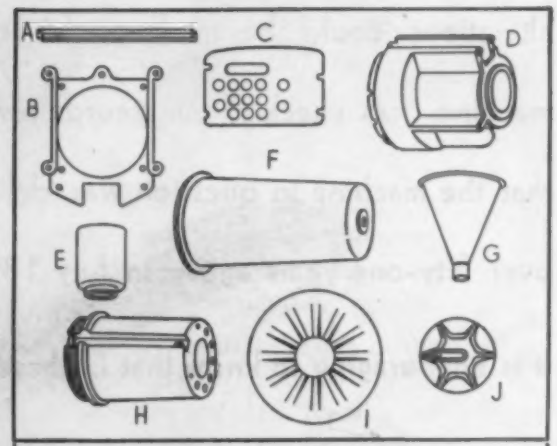
How to put your product on the right track

Steamed Up over improving an old product or introducing a new one? Just whistle and Continental's Plastics Division will be glad to help you get the most pull out of that product.

Our engineers, designers and research men work closely with the leading raw material manufacturers, and have immediate access to all latest developments.* Our long experience counts when it comes to giving your product the qualities it needs—whether beauty, durability, toughness, lightness or any others.

Our Plastics Division is equipped to produce by any one of the modern fabricating techniques—compression, injection, extrusion, lamination or sheet forming—assuring you of the best possible service at the lowest possible cost.

So, no matter what your product problem may be, come to Continental. You'll find an alert, progressive organization equipped to give sound, practical advice and assistance at all times!



(a) Molding—extruded; (b) Mount for fog horn assembly—compression; (c) Keyboard cover—compression; (d) Military device—compression; (e) Retainer—compression; (f) Sales ticket holder—compression; (g) Funnel—compression; (h) Electrical device part—compression; (i) Sheave—compression; (j) Distributor rotor—compression.

CONTINENTAL CAN COMPANY, INC.

PLASTICS DIVISION

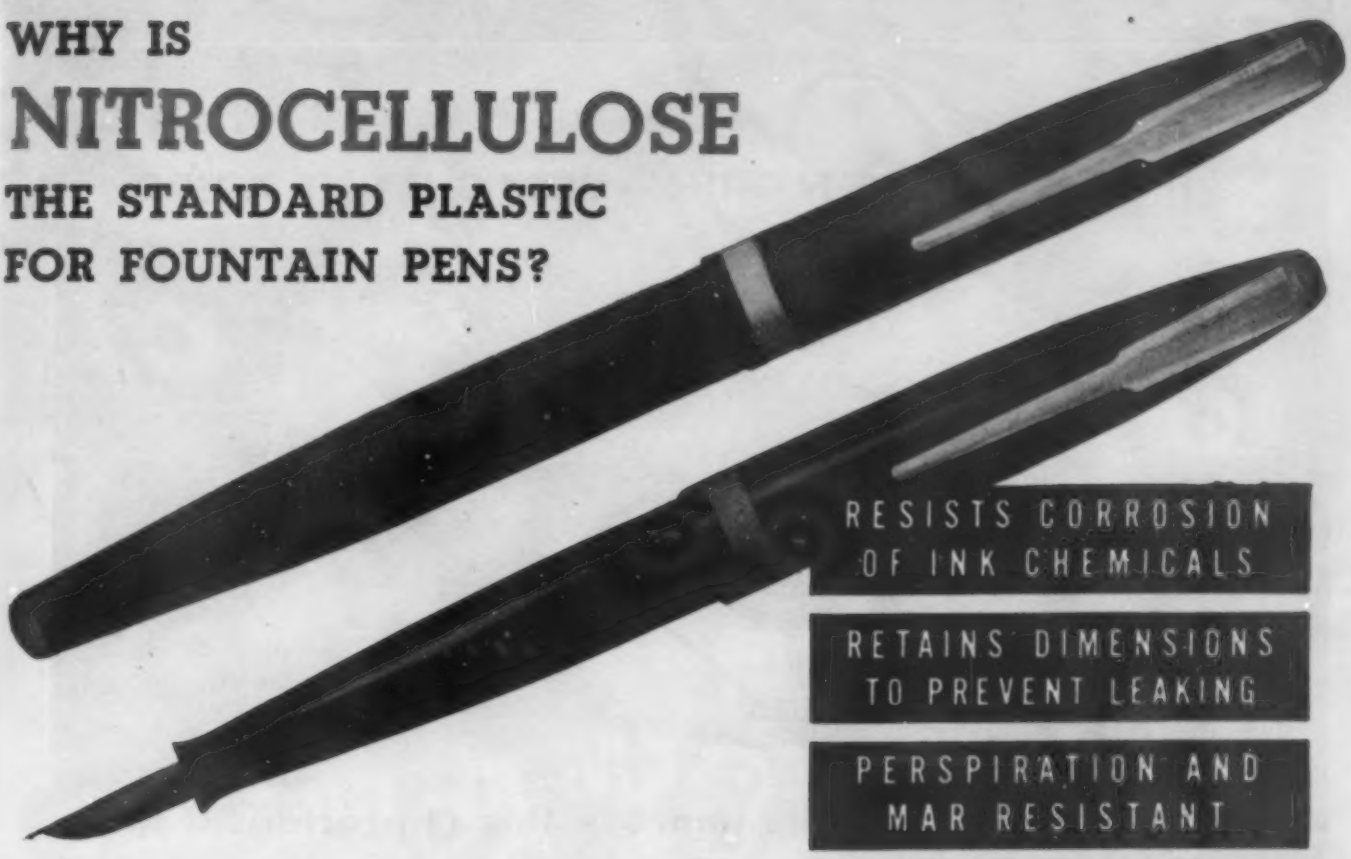
HEADQUARTERS: Cambridge, Ohio

Sales Representatives in all Principal Cities

COMPRESSION • INJECTION • EXTRUSION
SHEET FORMING • LAMINATION

***To give you the best** in plastics service, Continental has acquired Reynolds Molded Plastics of Cambridge Ohio. The facilities of this pioneer organization, combined with Continental's extensive resources, form a Plastics Division capable of designing, engineering and producing the widest range of plastic products for manufacturers and designers.

WHY IS NITROCELLULOSE THE STANDARD PLASTIC FOR FOUNTAIN PENS?



RESISTS CORROSION OF INK CHEMICALS

RETAINS DIMENSIONS TO PREVENT LEAKING

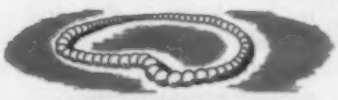
PERSPIRATION AND MAR RESISTANT

WIDER RANGE OF COLOR POSSIBILITIES

TOUGH, DURABLE, FOR ROUGH HANDLING

ALL THESE ADVANTAGES IN ONE LOW-COST PLASTIC

SO TOUGH
it is used to make billiard balls. (Toughest of all thermoplastics.)



SO BEAUTIFUL
in finish it is used to make luminous pearls.

SO EASILY FABRICATED
by drilling, punching, sawing, turning, . . . can even be printed and polished.

SO RESISTANT TO CHEMICALS
it is used to make storage battery casings.

SO STABLE
dimensionally (will not warp, swell, shrink) is used for drawing instruments.

SO UNLIMITED IN COLOR
possibilities—pastels, vivid opaques, tinted transparencies, and pearl effects.

SO RESILIENT
it is the standard for ping-pong balls.

SO CLEAR
it is used for identification card windows.

SO LOW IN COST
it is used to make thousands of beautiful, inexpensive trinkets and novelties.

FREE check chart

Includes helpful technical information and complete list of fabricators of nitrocellulose plastics. Write today for your free copy.

HERCULES POWDER COMPANY
INCORPORATED
916 Market Street Wilmington 99, Delaware

CP—41

FIBERGLAS* Textiles Improve this Characteristic in Low-pressure Plastic Laminates

FIBERGLAS . . . is the trade name for glass manufactured in fiber or filament form by Owens-Corning Fiberglas Corporation. The Fiberglas fibers, twisted into threads and yarns, woven into tapes and cloths, provide textile materials in all the standard forms used in the reinforcement of low-pressure plastic laminates. Samples and complete technical information on Fiberglas Textiles on request. Fiberglas Corporation does not manufacture resins or finished laminates, but shall be pleased to direct you to sources of supply.

HIGH STRENGTH with LIGHT WEIGHT . . . that is the prime objective in numberless postwar products . . . plastics, in particular.

The resourceful fabricators of low-pressure laminates are setting up new highs in the vital strength-weight ratio. They are reporting notable improvements in the strength-to-weight factor through the use of Fiberglas Cloth Reinforcements in combination with the new contact pressure resins.

Fiberglas . . . glass in the form of fine fibers or filaments . . . has a specific tensile strength beyond that of steel. Twisted into yarns, woven into Fiberglas Cloth and put into plastic laminates for reinforcement, Fiberglas carries its high strength with it. Fabricators are producing laminates with strength-weight ratios in excess of those of the high-strength metals.

And they are reporting that Fiberglas Cloth contributes in an important way to other desirable properties in finished laminates, such as impact strength, dimensional stability, moisture resistance.

If you are working to build up strength-weight ratios and other qualities in plastic laminates, you may find it highly profitable to look into Fiberglas Cloth and the results that are being achieved with it in combination with some of the new resins.

As a first step, write for reprints of published reports of comprehensive investigations of Fiberglas-reinforced, low-pressure laminates by the U. S. Army Air Forces. Address your request to *Owens-Corning Fiberglas Corporation, 1876 Nicholas Building, Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.*

FIBERGLAS

*T. M. Reg. U. S. Pat. Off.

. . . A BASIC MATERIAL

Planning On Molded Plastics?

● Many postwar ideas now growing into more finished form in engineering and drafting rooms will call for molded plastic parts.

For these, General Industries offers the services of its molded plastics division.

Please get us right. We make no pretense at *designing* your molded plastic parts. You know that job better than we ever hope to.

But, we can tell you whether it's a practical molded plastic job. We can help you select the right plastic compounds—and in many cases can suggest minor changes or refinements resulting in better parts, delivered faster or more economically.

This "know-how" extends through our mold-making and processing divisions. Small parts or large ones are carefully and skillfully engineered through the intricacies of mold-designing, so that when they leave the molds they are accurate in dimensions and finely finished.

Of course, we have the necessary machines for the molding of large or small work, in any quantities, by compression, transfer or injection processes. And we keep our delivery promises.

So, if you are planning postwar products that include molded plastics, keep in touch with General Industries. Right now, we're working 100% for Uncle Sam, but when the end of that is in sight, we'll be glad to work with you.

THE GENERAL INDUSTRIES COMPANY

Molded Plastics Division • *Elyria, Ohio*

Chicago: Phone Central 8431 — Milwaukee: Phone Daly 6818

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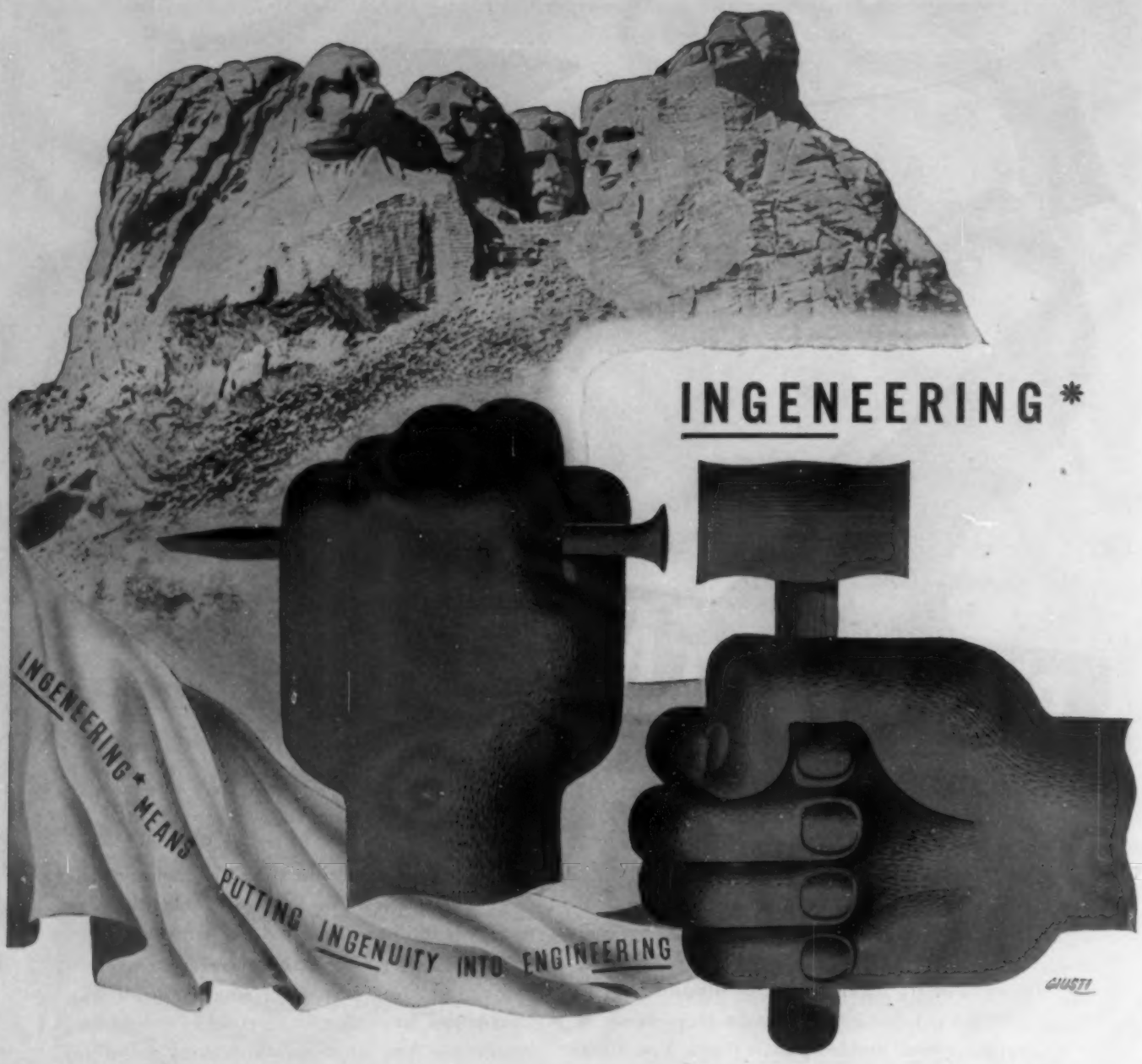
MOLDED PLASTICS

ARMY E NAVY



It takes more than hands and tools and materials to create things that rise above the commonplace . . . whether in sculpture or in plastics.

It takes alert minds, willing to defy tradition, yet wise in the technique of their vocation, to make the difference. That's the *plus* you get when Victory Plastics puts INGENEERING to work to win superiority for your post-war plastics product. Write us. Victory Plastics Company, Molding Street, Hudson, Massachusetts.

INGENEERS* OF PLASTICS PRODUCTS

Victory PLASTICS COMPANY

COMPRESSION • TRANSFER • INJECTION • LAMINATION • SATURATION

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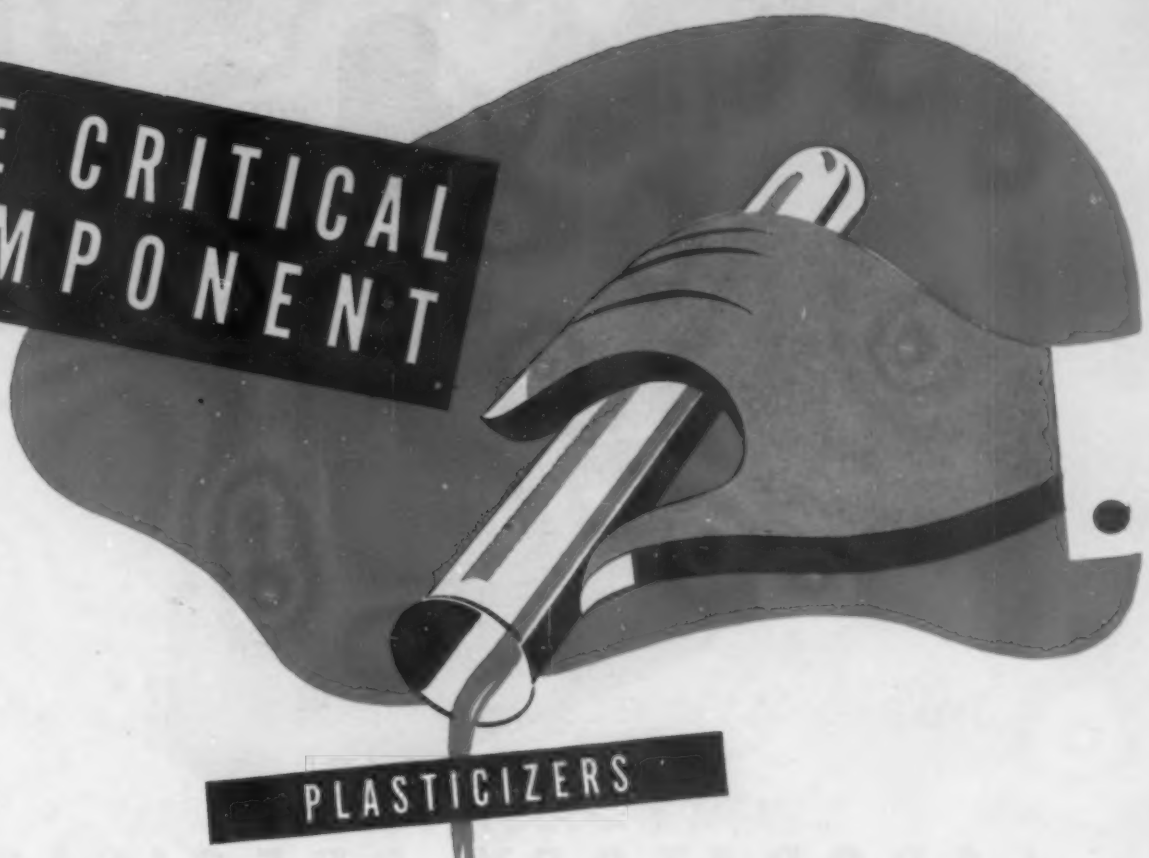
THE CRITICAL COMPONENT



PLASTICIZERS

Each component of a plastic composition is manifestly a critical one. This is axiomatic. Yet, in every process, there is one component that is more critical than any other in its effect on the finished product.

For example, in the many types of plastics, *the* critical component is often the plasticizer. It is for this reason that there has been so much research work done on plasticizers.

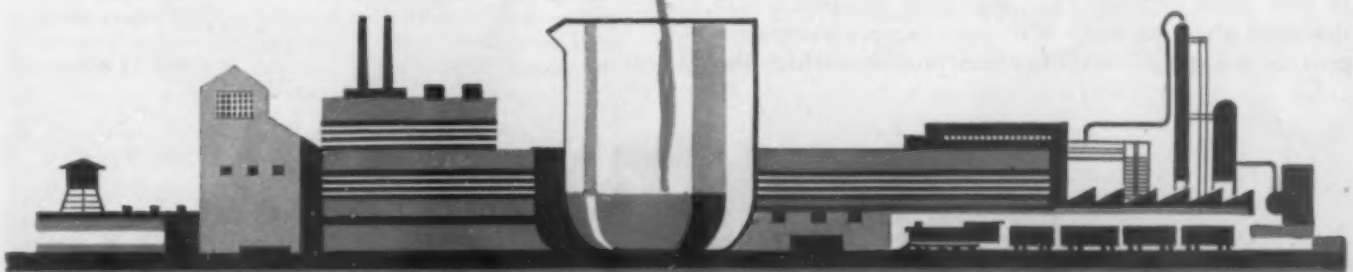
Emery has been working extensively on several new products to impart the flexibility and elasticity so important in many plastic products.

One of these . . . Azelaic Acid . . . is not found in nature and has never before been produced on a commercial scale. The esters produced from monohydric alcohols are high boiling liquids compatible with a wide variety of resins to which they impart an *exceptional plasticity at low temperatures* . . . a very desirable and critical characteristic in a plasticizer. It also combines with glycerine and other polyhydric alcohols to form *soft* alkyd resins.

Another new product is Emery's L-114, a composite of low molecular weight aliphatic acids in which the unusual acid . . . Pelargonic . . . predominates. The chain length of these acids is such that their oil solubility and low volatility fit them for use as modifying agents in the manufacture of alkyds, and make the products of their reaction with alcohol derivatives efficient plasticizers. The hydrocarbon chain is not so long, however, that the modified alkyds lack adhesion, nor that the plasticizers lack compatibility with resins.

One of the new esters . . . Emery's X-55 . . . is a versatile plasticizer of good color stability and low volatility. Its high plasticizing value is retained at low temperatures while stickiness does not develop at elevated temperatures.

These are just a few of the new Emery products. Many of them have received only laboratory evaluation, while others have been submitted to the more severe test of commercial usage. Full-scale production of all of them can be expected in the very near future. Laboratory samples, and further information will be furnished gladly upon your request.



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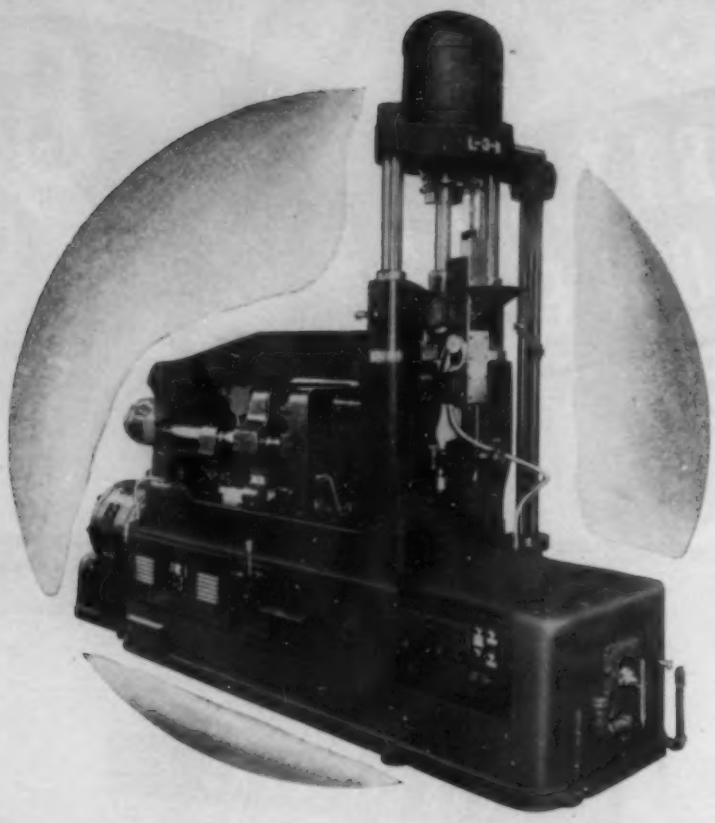

LABORATORY PRECISION on a PRODUCTION BASIS

It's easy to make perfect moldings in a laboratory, with all conditions under exact control and skilled technicians operating the molding equipment. It is *not* so easy (as many molders have learned the hard way) to repeat the performance millions of times, year in and year out, under the far-from-ideal conditions of actual production.

Unless, of course, you own a Lester . . . This superb piece of injection molding equipment is the one machine which assures laboratory precision on a production basis. Exclusive Lester construction features* make possible the high-speed production of molded parts whose dimensional accuracy, structural strength, and molecular stability are not duplicated by ordinary molding machines.

Is *your* plant equipped for successful competition in the years after the war? Will your present equipment provide the speed, versatility and precision which the coming market will demand? Will your moldings compare favorably in quality with the best of the industry. If you are using Lesters . . . the answer is an emphatic YES! If not, you should at least investigate the facts which we have to offer.

A Lester engineer will be glad to go over your plans with you . . . provide skilled advice on both product and die design . . . tell you exactly how and why the Lester is America's premier injection molding machine. Drop us a line for free literature.

*(1) Vertical heating cylinder with hollow injection plunger for high heating efficiency. (2) Extra, interchangeable heating cylinders for each model widen operating range. (3) Positive die locking holds flash on moldings to rock-bottom minimum. (4) Central die adjustment assures perfect parallelism of die plates. (5) Heavy alloy steel beam frame gives rigid support to die locking mechanism. (6) Size range—4, 6, 8, 12, 16 and 22 ounces.

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Plastics coat hook capable of supporting 280-pound weight. Molded by Pyro.

This plastics scoop replaced heavier metal type. Injection molded by Pyro.

Small, exclusive restaurants often earn a nationwide reputation for excellence . . . deservedly so, because their size permits them to specialize and to cater to a smaller clientele.

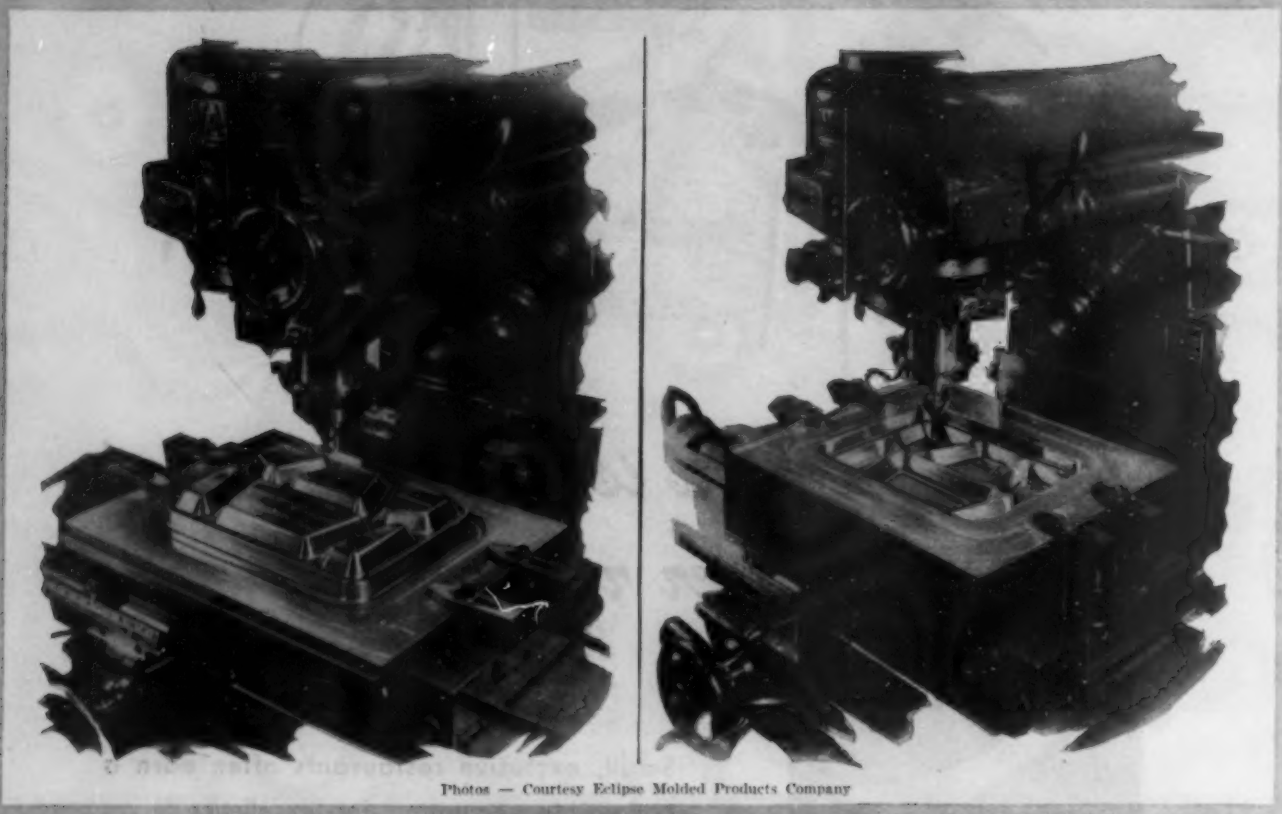
In selecting a custom molder, it often pays to go where every inquiry gets individual attention . . . where excellence rather than quantity is the principal consideration.

While our facilities are ample to take care of large production jobs, our organization is small and closely-knit...ideally suited to handle molding problems requiring individual attention.

For fine workmanship specify **Pyro** *molded plastics*

THE PYRO PLASTICS COMPANY · WESTFIELD · NEW JERSEY

How would you handle this Job in your Shop?



Photos — Courtesy Eclipse Molded Products Company

1001

Molds for plastics pose some tough milling problems occasionally. Here's a tray mold — that could have been difficult, but it was completed on a Milwaukee Rotary Head Milling Machine with typical speed, economy, and accuracy.

Read this job report —

TRAY MOLD

CAVITY SIZE — width, 12 inches, length, 15½ inches, depth, 1½ inches.

Time required for milling both mold halves complete — 219 hours.

All form cutters milled to correct size and shape on the Milwaukee Rotary Head Milling Machine.

Check these advantages of the Milwaukee Rotary Head Milling Machine and how you can benefit from them in your own shop:

DIRECT . . . mills mold cavities in a single set-up without the aid of templets or models.

ACCURATE . . . chances for error are eliminated because there is no change in set-up. Exact control of all combinations of cutting movements—possible only with this machine—transmits mathematical precision to the work.

FAST . . . initial job preparation and set-up time is reduced to the minimum. Accurate performance of the machine saves operator's time and rapid production of intricate molds and dies is the result.

Write for Bulletin No. 1002C and complete information.

BUILDERS OF MILWAUKEE ROTARY HEAD MILLING MACHINE • MIDGETMILL • SPEEDMILL • FACE MILL GRINDER • AUTOMETRIC JIG BORER • CENTER SCOPE.

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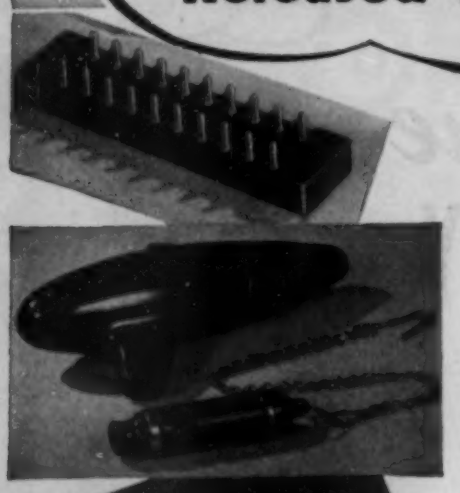

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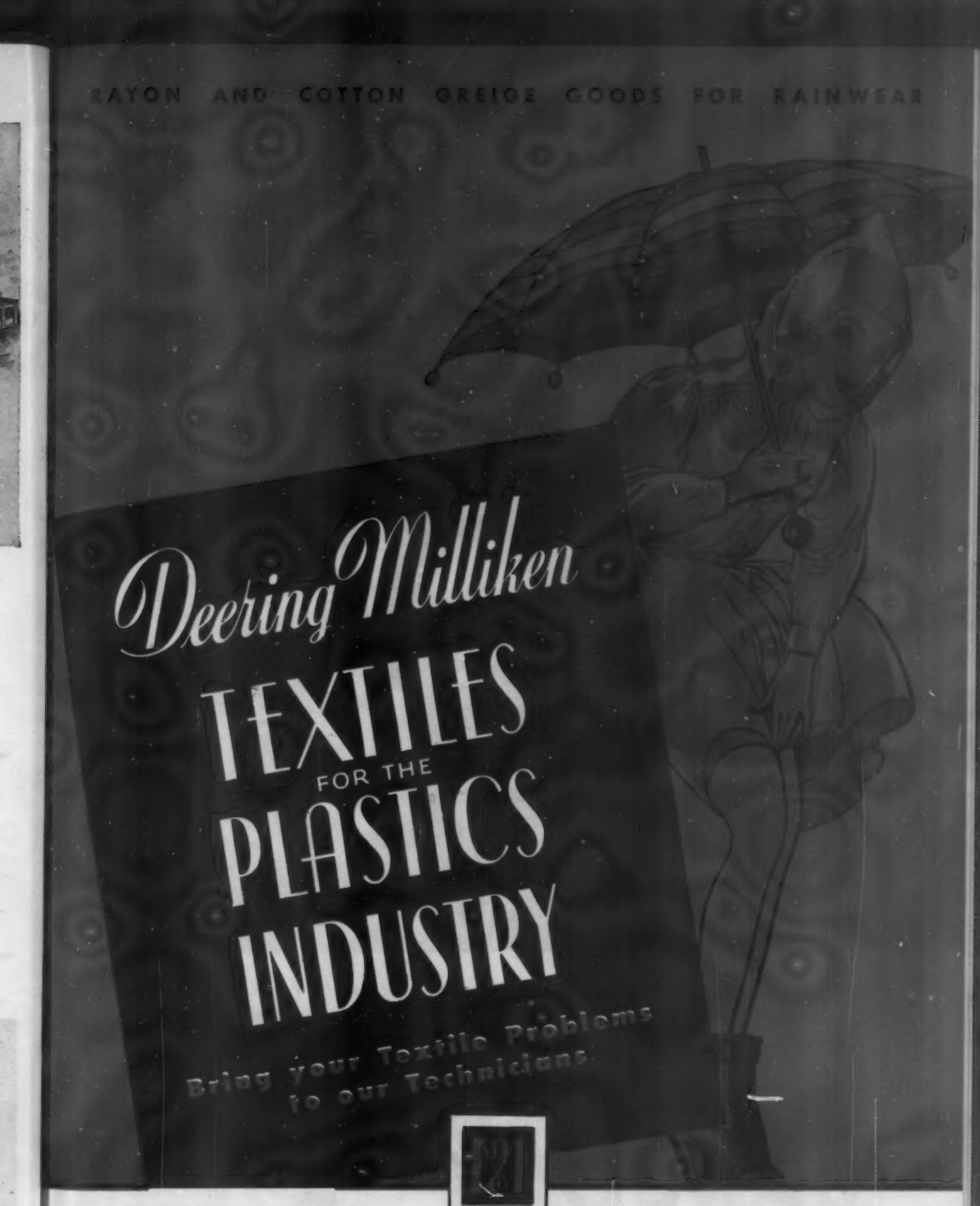

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Fluid-conveying pipes carry the life-blood of industry and transportation. Vital links in these conveyor systems are Barco Flexible Joints—enemies of vibration and shock. Providing responsive movement through every angle, Barco compensates for all stress and strain, expansion and contraction. Over 30 years' experience in solving flexible joint problems is yours when you consult Barco's engineering department.

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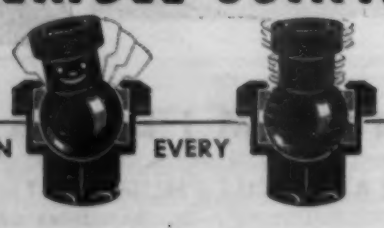

Not just a swivel joint...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

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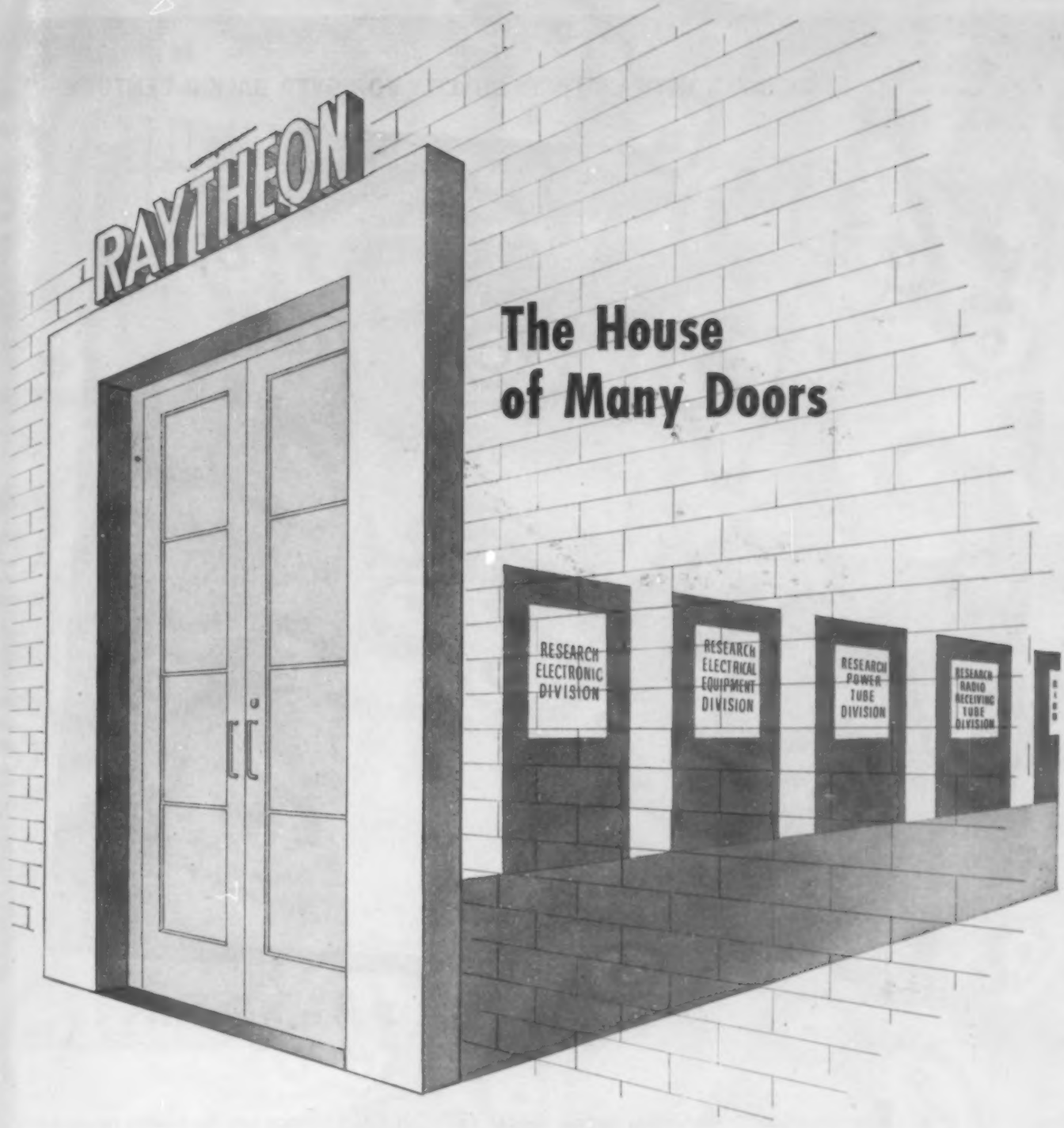
"MOVE IN EVERY DIRECTION"



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RAYTHEON is truly a house of many doors . . . doors that lead to many research, engineering, and production groups which have made great contributions to the quality and quantity of electronic equipment and receiving and transmitting tubes now helping the armed forces.

Today, behind these closed doors over 16,000 men and women are devoted to war work. Tomorrow, these doors will be wide open and through them will come new developments in all phases of electronics.

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Devoted to research and manufacture of complete electronic equipment; receiving, transmitting and hearing aid tubes; transformers; and voltage stabilizers.

The dependable uniformity found in MT. VERNON Extra fabrics has long been recognized in the plastics field as a major aid in the making of successful laminates. Achieved by careful laboratory control checks which guide every step of MT. VERNON fabric's production, this high degree of uniformity induces deep and uniform penetration of plastic materials employed. For fabrics which present minimum processing problems and laminates that provide maximum uniform quality, specify MT. VERNON Extra.

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"HITS ON ALL SIX"

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5. Close tolerance requirements followed through . . . with precision results.
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From pencilled sketches to finished plastic products, you can depend upon Consolidated's way! Five convenient office branches to contact you—and one central, modern, fully equipped plant to serve you. Inquiries invited.

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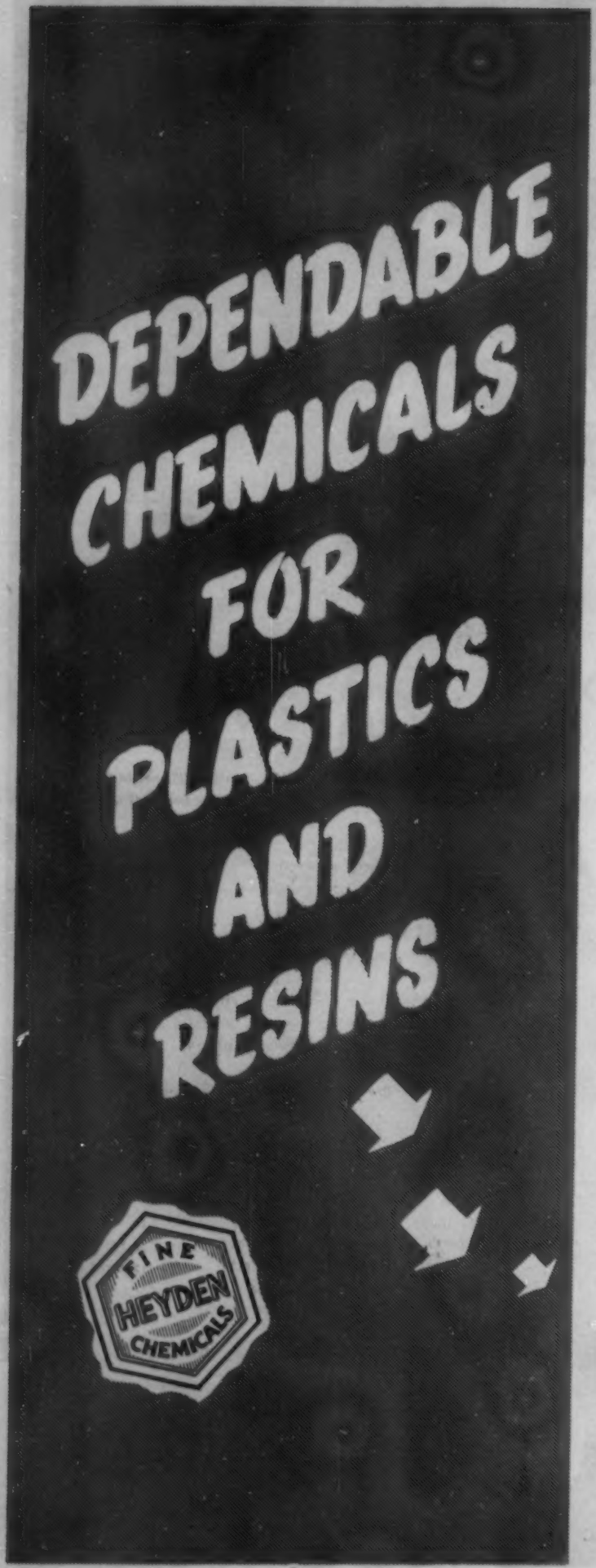

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PENTEK* (Pentaerythritol Technical)

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Produced and controlled in modern plants by expert personnel, Heyden Chemicals are accepted as standards of excellence for the manufacture of plastics, synthetic resins and protective coatings. The high purity and uniform strength of chemicals by Heyden assures manufacturers of consistent yields and high quality finished products.

Qualified technical personnel are available to help you with information on the use and handling of these Heyden Chemicals.

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Let's stop dreaming-

The post-war is nearly here!

You may have noticed that we have been poking a little fun at some of the post-war dreams which have been plaguing manufacturers and consumers alike.

We don't believe in dreams. And now that the war is within measurable distance of being over, the *real* post-war problems must be faced.

They are problems of efficiency, economy and speed—and we are ready to answer them for all industries with extruded plastics.

We have pioneered applications beyond count in almost every field of industry from airplanes to refrigerators and even in agriculture. We are working now with many leading industrialists and designers on *real* post-war applications of extruded plastics.

We would like to work with you.

We also do injection molding.

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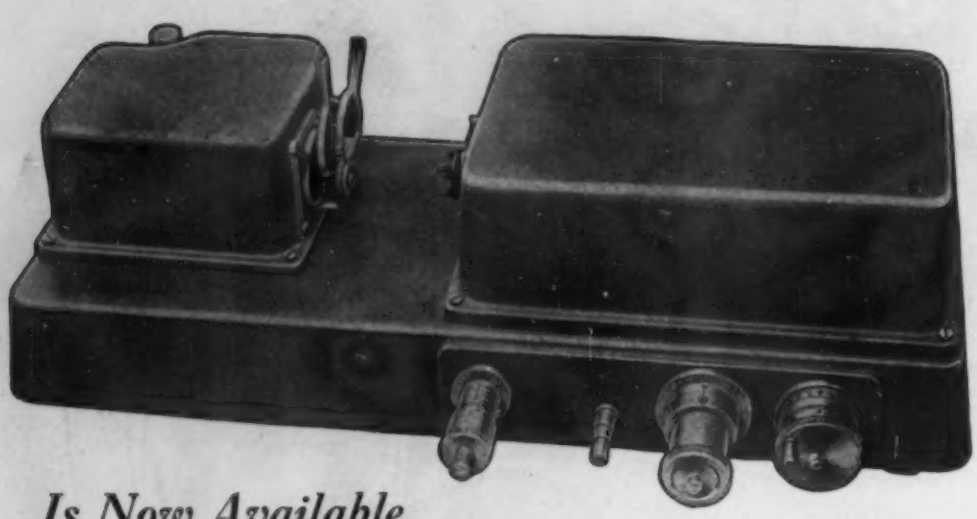
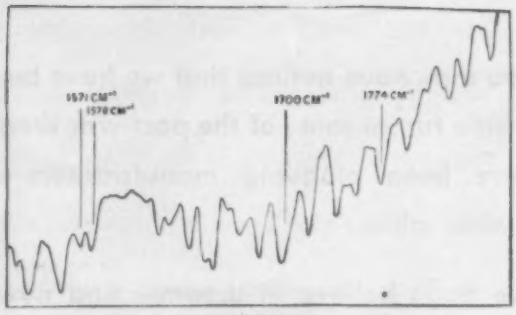


*Is Now Available with Recorder and Amplifier**

The new Perkin-Elmer recording Infrared Spectrometer provides a method for the direct identification of characteristic functional groups in complex molecules, replacing a multiplicity of specific chemical tests. Unique "fingerprints" of molecules obtained by this method — their complete infrared spectra — give positive compound identification. The instrument's photometric accuracy makes possible quantitative analyses of many complex mixtures and direct comparisons with known calibration standards.

*The recorder and amplifier can be obtained separately or mounted with the spectrometer in a single cabinet that can be set up in any laboratory where water and power are available. Pen and ink records of spectra are obtained directly on the eleven inch width strip chart. They are illustrated in the sample spectrum of the 6 micron water vapor absorption band at the right, made with these accessories and a rock salt prism. The charts are accurate enough for precise intensity and wave length measurements and also serve as permanent records that may be remeasured at any time to determine additional information. The amplifier used in place of the galvanometer is available only to those working directly or indirectly on Government contracts.

At your request, we will gladly send you further information about the advantages of infrared spectroscopy and the Perkin-Elmer recording Infrared Spectrometer.



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- Simple prism mounting for easy interchange of prisms.
- Grouped controls.
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- Accurate, adjustable correction of wave length scale for temperature changes.

P E C

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Because They're Small They Have To Be Good

The smaller the grinding wheel, the more critical its quality. Each grain has all the greater responsibility. But small grinding wheels are more difficult to *make* than larger ones—it requires extra care to control consistency of the abrasives throughout each mounted wheel or point and from one to another. Bay State overcomes the difficulty by special manufacturing procedures which result in a better product, easier to use and with longer life.

Each Blue Flash mounted wheel or point is *turned down* from a large blank, and is sized and shaped *on* its own mandrel. Thus, they

need no breaking-in period, because they are dressed as they are shaped.

run absolutely true, because each is concentric to its mandrel.

have no hard and soft spots, because the consistency of grain and bond is uniform throughout.

can be used right down to the mandrel, because the manufacturing process automatically provides a positive test for adhesion of abrasive to mandrel.

These advantages of Blue Flash Mounted Wheels and Points are typical of what you can expect from the entire Blue Flash line. Into each type of product, Bay State builds *extras* that can be easily appreciated when on the job. Write for literature on the products you use—including the handy, pocket-sized catalog on mounted wheels and points.

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WESTBORO, MASS.

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MOUNTED WHEELS AND POINTS · CUT-OFF WHEELS · INSERTED-NUT DISCS · AND CYLINDERS

THE season of sentiment is close upon us—
Hence this outburst—

To Our Customers:

Without you we die—and yet,
The relationship has been a very pleasant one—

Please forgive us our sins and errors of commission and omission

Which we admit (for the sake of this statement only)
Are many.

Best Wishes for the Holiday and New Year.

To Our Competitors:

Without you we'd probably be in jail—
And yet—in spite of appearances—
Which are against you—
You are really very nice people.

Don't count too much on the above admission.

To you all, merry and otherwise,
A very happy and moderately successful—

Holiday and New Year.

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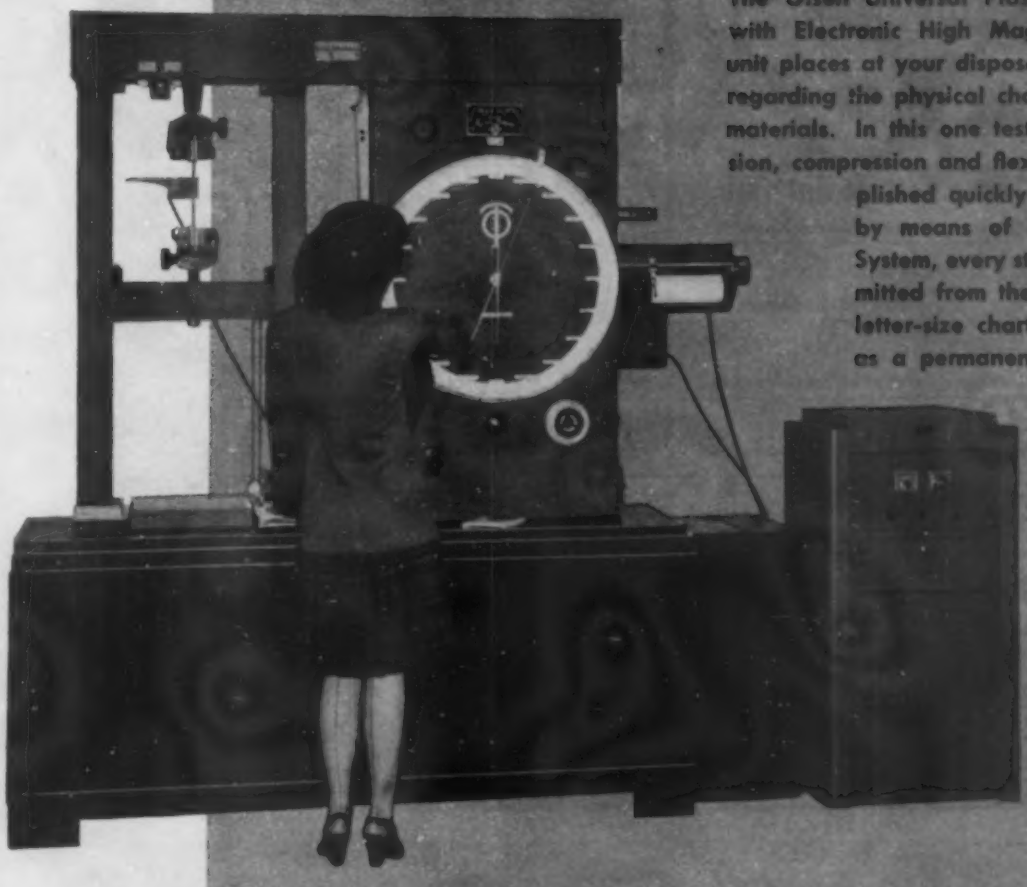
ACCURATE STRESS-STRAIN CURVES OF PLASTIC MATERIALS

THE OLSEN PLASTIVERSAL

with Electronic High Magnification Recorder



The Olsen Universal Plastics Testing Machine with Electronic High Magnification Recording unit places at your disposal in chart form facts regarding the physical characteristics of plastic materials. In this one testing machine all tension, compression and flexure testing is accomplished quickly and accurately, and by means of the unique Sivertsen System, every step in the test is transmitted from the extensometer to the letter-size chart which may be filed as a permanent record of the test. The information so recorded is of vital use in standardization, production control, design and use of plastic materials.

***THE STRESS-STRAIN CURVE PUTS THESE FACTS AT YOUR COMMAND**

1. Plasticity
2. Modulus
3. Stiffness
4. Yield Strength
5. Brittleness
6. Compression Strength
7. Deflection
8. Ultimate Strength in Tension and Compression

Write today for your copy of Bulletin 23 describing the Plastiversal and other Olsen Plastics Testing Equipment.

Proving Every Day that the Value of Testing Depends on the Quality of the Testing Equipment.

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PLAX SUPPLIES these materials ↓ in these forms →	Film & Slab	Rod	Tubing	Fiber
	Depending on the material, film and slab come from .001" to 2.0" thick . . . rod from ⅛" to 6" diameter . . . tubing, to order . . . fiber from .005" to .090" diameter.			
Cellulose Acetate *In all colors, clear to pearlescent*	✓	✓	✓	✓
Cellulose Acetate Butyrate *In all colors, clear to pearlescent*	✓	✓	✓	✓
Ethyl Cellulose *In all colors, clear to pearlescent*				✓
Methacrylate *In all colors, clear to pearlescent*		✓	✓	✓
Polyethylene	✓	✓	✓	✓
Polystyrene *In all colors, clear to pearlescent*	✓	✓	✓	✓
Styramic	✓	✓		

Exclusive Plax developments have included the tough and flexible Polyflex* Sheet and Polyflex Fiber forms of polystyrene. Continuous research work, and a ready understanding of all application problems, make "PLAX FOR PLASTICS" more than a slogan. It should prompt you to ask today for scientific help. Write Plax Corporation, 133 Walnut St., Hartford 5, Conn.

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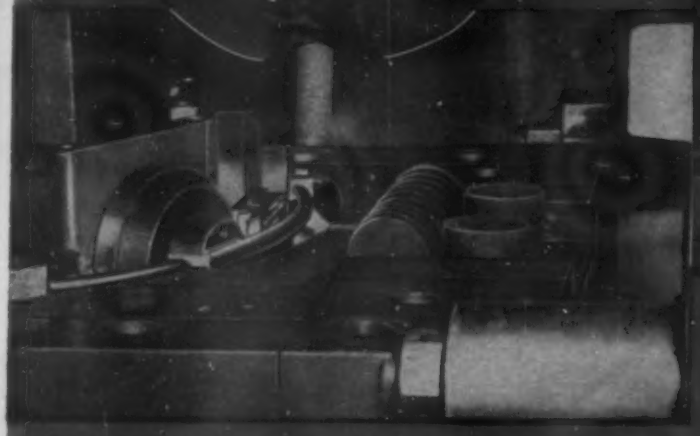
-MEGATHERM-*

CUTS MOLDING TIME 90%



▲ *The molded handset ready for ejection from the mold after the 30 second perfect cure.*

◀ *Megatherm heated preforms in preci transfer chamber just before closing.*
Photos Courtesy Plax Products Co.

Federal Industrial Power Tubes, give power and performance to Megatherm and other industrial heating equipment.

Molding time on these telephone handsets was reduced from five minutes to 30 seconds with Megatherm.

In addition to rapid molding Megatherm provided a complete and uniform cure which was free of all internal stress.

Megatherm is doing plastic preform heating *better* and *more quickly* than any other method. In many cases Megatherm has made a plastic molding job possible which could not be done by other methods.

Megatherm units are compact, and may be easily moved from one production line to another. One of the four standard models will fit your production needs. Megatherm is available in 3 KW, 7 KW, 15 KW and 25 KW output capacities.

Cost of operation is low, the popular 3 KW Megatherm has a power cost of 5¢ per hour.

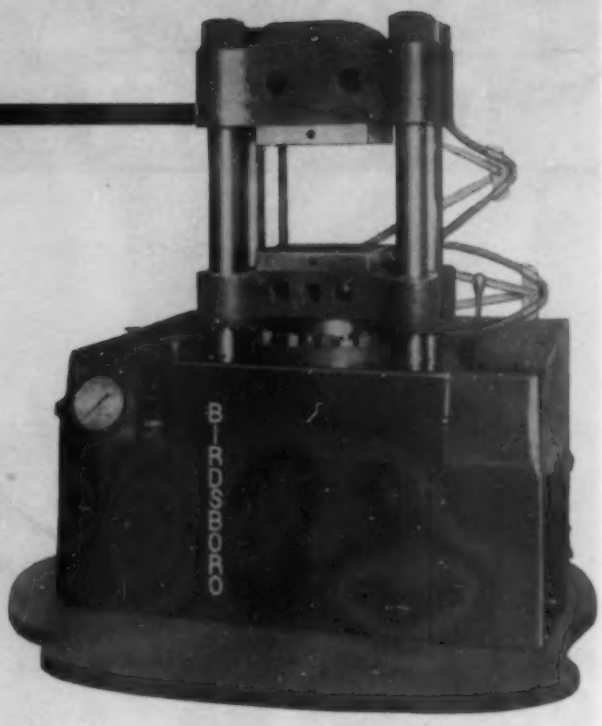
If you have a plastic preheating problem, now is the time to talk about it with Federal.

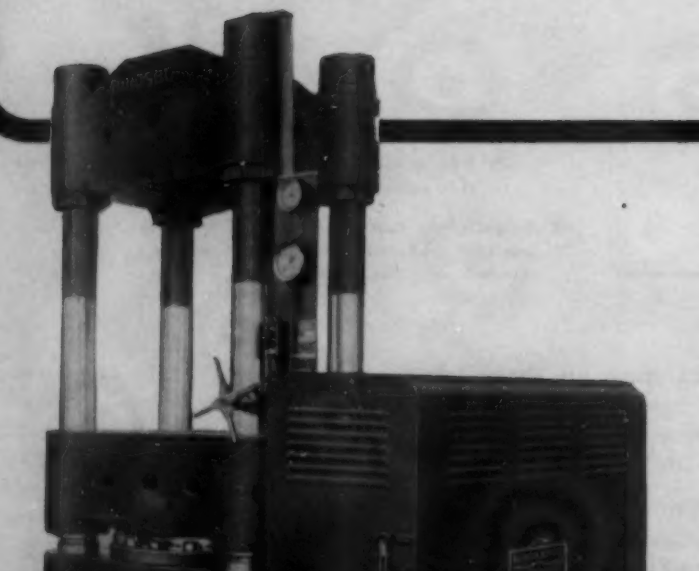
Federal Telephone and Radio Corporation

INDUSTRIAL ELECTRONICS DIVISION Newark 1, N. J.

*REG. U.S. PAT. OFF.

IMMEDIATE PRODUCTION ... *with* SELF-POWERED PRESSES





These BIRDSBORO Self-Powered Plastic (Compression) Molding Presses are equipped with built-in Hydraulic systems complete with pumps and controls capable of producing required variable pressures and rates of speeds. This means that plants without existing accumulator facilities can rapidly get into production with these Birdsboro Plastic Compression Molding Presses.

Our specialty is designing and building hydraulic presses to meet the needs of the plastic industry. Take advantage of Birdsboro's long press-making experience to secure the presses you will need to meet competition.

BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY • BIRDSBORO, PENNSYLVANIA

BUY WAR BONDS

BIRDSBORO

HYDRAULIC PLASTIC PRESSES

Sorry, Mortimer —

you'd be too rough on our customers!

THE MAN who runs your plastics job at Kurz-Kasch isn't run-of-the-mill material—and he doesn't start from scratch. He's either learned molding through long years of Kurz-Kasch training, or he has graduated from an apprenticeship following a thorough job-training course.

We've got a couple of other new wrinkles too, even if we are one of the oldest names in the business. For instance we've got a complete shop for producing all types of metal inserts right in the plant. And extensive radio-frequency preheating equipment—with more experience with it than most.

If you know plastics, you know that these production improvements—plus the facilities described here—make for the progressive but sound type of leadership you want to find in your molder. If you don't know plastics, knowing your molder helps even more. Put your plans up to Kurz-Kasch today, and see for yourself.

WHY KURZ-KASCH FOR PLASTICS? Kurz-Kasch offers a 28 year old reputation for thoroughly-engineered, quality production. • One of the largest, best-equipped exclusive custom molding plants in the country—75,000 sq. ft. of floor space with 125 compression and transfer presses of all sizes. • Complete mold-making and finishing facilities. • Extensive production sequences of radio-frequency preheating equipment, with full experience in their use. • Complete insert-production shop. • For satisfaction in plastics, key these facilities into your production line.

BUY WAR BONDS FOR VICTORY — HOLD THEM FOR PROFIT

Kurz-Kasch

For over 25 years Planners and Molders in Plastics

Kurz-Kasch, Inc., 1415 South Broadway, Dayton 1, Ohio. *Branch Sales Offices:* New York • Chicago • Detroit Indianapolis • Los Angeles • Dallas • St. Louis • Toronto, Canada. *Export Offices:* 89 Broad Street, New York City

NIXON NITRATION WORKS • NIXON • NEW JERSEY

Better

COMPRESSION AND TRANSFER MOLDING

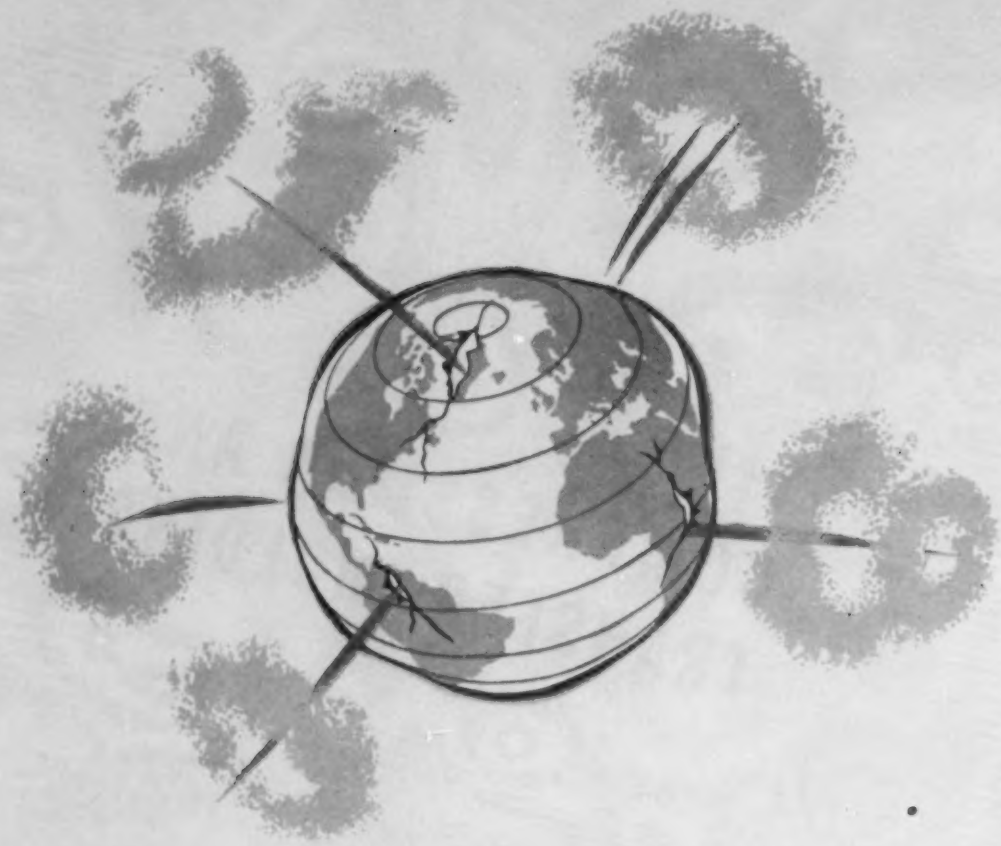
with Automatic Controls

Fine production of plastic parts means close supervision and the use of AUTOMATIC controls. Our prewar work and our war production shows clearly the character of I.M.P. molded plastic parts. We are well equipped to handle production of small parts on AUTOMATIC MACHINES, such as control knobs, electric switch cases, dial pointers, handles, etc., with speed and precision. Write us about your requirements.

IMP

4387 WEST 35th STREET
CLEVELAND 9, OHIO

INTERNATIONAL MOLDED PLASTICS, *Inc.*



Just A-Puffin' and A-Poppin'

The world is just popping at all seams from the plastic materials and designs that are waiting for war's end to come to the surface. When that day comes, we expect to make certain contributions to plastic container progress. Meanwhile, we continue to produce closures by the billions —closures for bottles and jars that are going overseas to our armed forces and our allies—closures for containers supplying the home front, too. If you have a problem in getting the right closure for your containers, write the Closure and Plastics Division. It is rather likely that our "know-how" can help you solve your problem.

Enjoy "Another Lift to Selling," the Owens-Illinois Radio Program—Fred Waring and his Pennsylvanians every week over the Blue Network from coast-to-coast. Look in your newspaper for local time and station.

CLOSURE AND PLASTICS DIVISION

OWENS-ILLINOIS GLASS COMPANY

TOLEDO 1, OHIO

Branches in All Principal Cities—Pacific Coast Division, San Francisco

TALK TO TAYLOR NOW ABOUT THE PART LAMINATED PLASTICS WILL PLAY IN YOUR POST-WAR PRODUCTS

Many forward-looking manufacturers who are determined to avoid a lengthy shut-down between war-production and peace-production are already working on blueprints of their proposed post-war products.

To help you *now* with your post-war plans, we have created and manned a Post-War Development Department. This Department has *no duties* other than those of discussing with forward-looking manufacturers the contributions that Laminated Plastics (Phenol Fibre and Vulcanized Fibre) can make to the performance and economy of the products of tomorrow.

Before you decide that a product or a part can best be made from glass, steel, wood, or any other material, it will pay you to find out whether or not that product or part can be made better, cheaper, or faster in laminated plastics. Consultation on such problems with the engineers in our Post-War Development Department is yours for the asking, without cost or obligation. Write us, in complete confidence, about your plans and problems.

Mass-produced by machining from tubes of Phenol Fibre, this radio part combines light weight, high dielectric quality, low moisture-absorption, and the ability to stand severe shock. Whatever combination of qualities you require, it's a rare case indeed that can't be solved by Laminated Plastics.

POST-WAR DEVELOPMENT DEPARTMENT OF

TAYLOR FIBRE COMPANY

LAMINATED PLASTICS: PHENOL FIBRE · VULCANIZED FIBRE · Sheets, Rods, Tubes, and Fabricated Parts

NORRISTOWN, PENNSYLVANIA · OFFICES IN PRINCIPAL CITIES · PACIFIC COAST HEADQUARTERS: 344 S. SAN PEDRO ST., LOS ANGELES

Continental-Diamond
Engineered Dielectric Materials

DILECTO parts, like those illustrated, are used throughout communications systems, detecting devices and controls wherever electrical currents must be insulated. DILECTO electrical insulating parts must function satisfactorily regardless of humidity, dryness, vibration, concussion. They must be mechanically strong . . . resistant to moisture and temperature . . . and dielectrically effective. In all these requirements DILECTO excels.

DILECTO is also readily fabricated. It may be machined, punched, drilled, tapped, and even formed. It is made in many grades . . . each engineered to meet specific electrical or mechanical problems. DILECTO may be the answer to your "WHAT MATERIAL?" problem. Send for catalog "DO" which gives complete technical and physical data.

KB-44

C-D PRODUCTS

The Plastics

DILECTO—A Laminated Phenolic.
CELORON—A Molded Phenolic.
DILECTENE—A Pure Resin Plastic Especially Suited to U-H-F Insulation.
HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

The NON-Metallics

DIAMOND Vulcanized FIBRE
VULCOID—Resin Impregnated Vulcanized Fibre.
MICABOND—Built-Up Mica Electrical Insulation.

Standard and Special Forms

Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

Descriptive Literature

Bulletin GF gives Comprehensive Data on all C-D Products. Individual Catalogs are also Available.

DISTRICT OFFICES
NEW YORK 17 • CLEVELAND 14 • CHICAGO 11
SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES

WEST COAST REPRESENTATIVES
MARWOOD LTD., SAN FRANCISCO 3

IN CANADA:
DIAMOND STATE FIBRE CO. OF CANADA, LTD., TORONTO 8

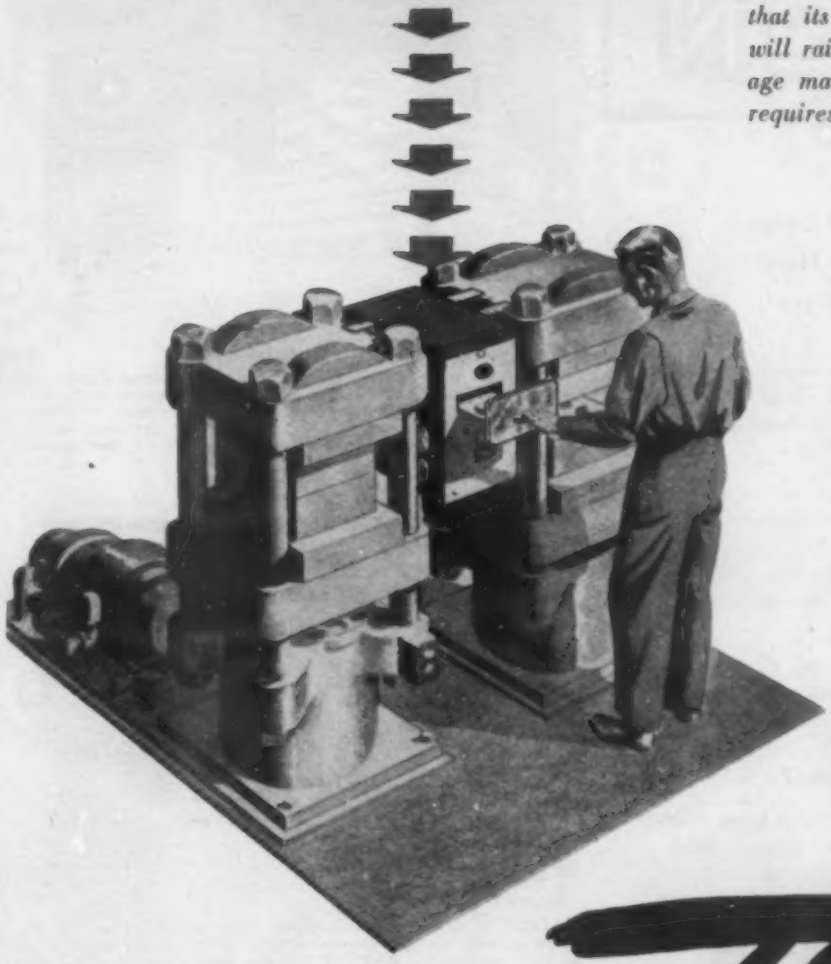
Continental - Diamond FIBRE COMPANY

Established 1895. . Manufacturers of Laminated Plastics since 1911—NEWARK 28 • DELAWARE

THERMEX PIONEERS AGAIN—WITH THIS *MASS PRODUCTION* HIGH FREQUENCY HEATING UNIT!

ONLY 15″ WIDE, 22″ HIGH AND 27″ DEEP AND WEIGHS APPROXIMATELY 250 LBS.

The No. X875 Thermex can be easily installed so that its drawer is at convenient operating height. It will raise the temperature of 1/3 of a pound of average material 170° F. in one minute. More material requires proportionately more time.



This new Thermex development opens *new fields of production possibilities* in plastics! It makes high frequency heating *thoroughly practical* for large operations and high-speed volume production of small to medium-large compression and transfer moldings. The unit will serve the majority of all press capacities —usually in pairs, alternately. It is completely self-contained and can be easily installed between or in front of the most compact existing arrangements of presses. This new Thermex h. f.* unit offers all the features that have distinguished larger Thermex equipment for the plastics field: (1) completely automatic operations; (2) fully enclosed heating compartment; (3) roomy, removable work tray drawer; (4) sturdy, simple construction. For details about the No. X875 model Thermex, address The Girdler Corporation, Thermex Division, Louisville 1, Ky.

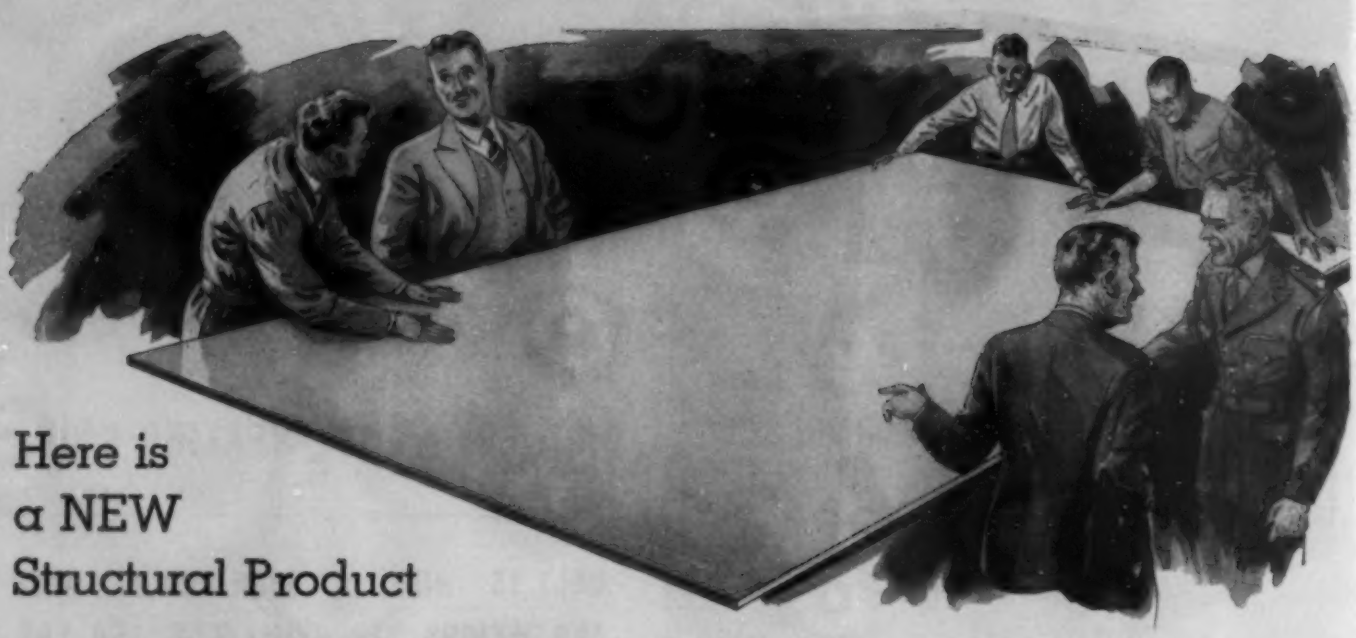
ANOTHER

Thermex

RED HEAD

THE FIRST INDUSTRIAL
*HIGH FREQUENCY DIELECTRIC
HEATING EQUIPMENT

A GIRDLER PRODUCT



Here is a NEW Structural Product

INDERON

A High-Strength Material, in Large Panel Form, With a Smooth, Hard, Infrangibly-United Plastic Surface!

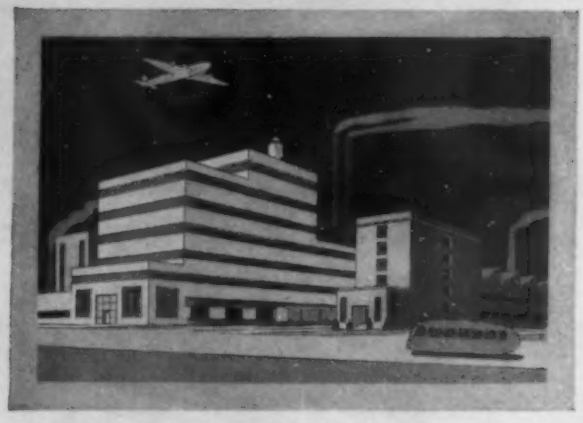
INDERON was developed as a utility container material for the Army Air Forces, was later adapted to many other war uses where strength, durability and dense, hard surface qualities were essential.

INDERON is waterproof, highly resistant to abrasion, impact, vapor permeation and other destructive forces. INDERON, made by chemically and infrangibly uniting Douglas fir veneers, plastic glues and a fibrous plastic film, is a large-size structural product which needs no surface protection, no decorative treatment, no structural support.

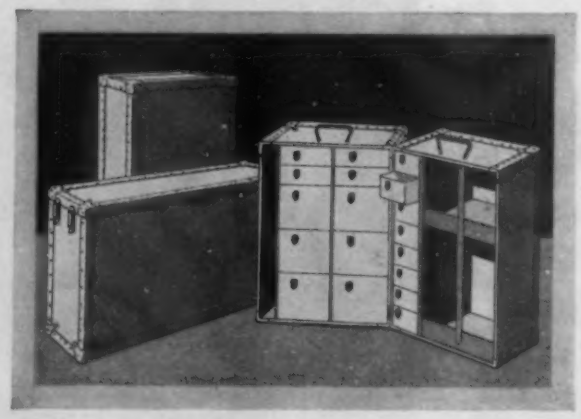
INDERON is stable. It does not warp or twist. It combines beauty, strength, durability and the economical panel form of standard plywood.

What Are the Uses of Inderon?

INDERON has literally thousands of applications in such fields as: Marine, Aviation, Railroad, Bus and Truck, Home, Office, Apartment, Farm and General Industry. Available now only for Army-Navy use. INDERON will become one of the most useful of all structural products in the post-war era. Write NOW for full information!



INDERON has innumerable applications as an industrial construction material. INDERON'S combination of structural strength and smooth, hard-wearing surface makes it ideal for use in many types of fixtures, handling equipment, assembly tables and special containers—as well as for factory flooring, office fixtures, work tables, and sanitary partitions.



INDERON is successfully serving the Army Air Corps as the preferred material for packaging many vital parts, medical supplies and delicate instruments. INDERON has also been used for many other important war purposes and has proved its ability to resist tropical fungus, termites, weathering and water immersion.

Manufacturers

Buffelen Lumber & Mfg. Co.
Tacoma 1, Washington

Washington Veneer Co.
Olympia, Washington

For Information, write
Chicago Sales Office
9 So. Clinton St., Chicago 6, Ill.

NORTON LABORATORIES (INCORPORATED)

CUSTOM MOULDERS OF SYNTHETIC PLASTICS
BAKELITE DUREZ

LOCKPORT, N.Y.

NORLOC NOVELTIES

ALL AGREEMENTS ARE CONTINGENT UPON STRIKES, FIRES, ACCIDENTS OR CAUSES BEYOND OUR CONTROL.
CONTRACTS WITH AGENTS NOT VALID UNTIL APPROVED BY AN OFFICER

December, 1944

Dear Americans:

This is the traditional holiday season and we do not intend to spoil it by striking any harsh commercial note.

We wish you---all of you---a sincerely merry Christmas. This goes for customers and non-customers and yes, for our competitors too.

This is a great industry we are in, and it is expanding fast enough for all of us to grow with it. We all contribute our little specialties, fill our small niches, and in the aggregate we are all growing up with plastics.

Perhaps the best gift we can give to anyone is to acquaint them with molded plastics. Perhaps we might work out some interesting new labor-saving piece which would cut your costs and speed your production. Perhaps you are in a highly competitive industry where the sales appeal of plastics might play an important part. Or, maybe you are just looking for a good, reliable source of supply for any kind of plastics molding.

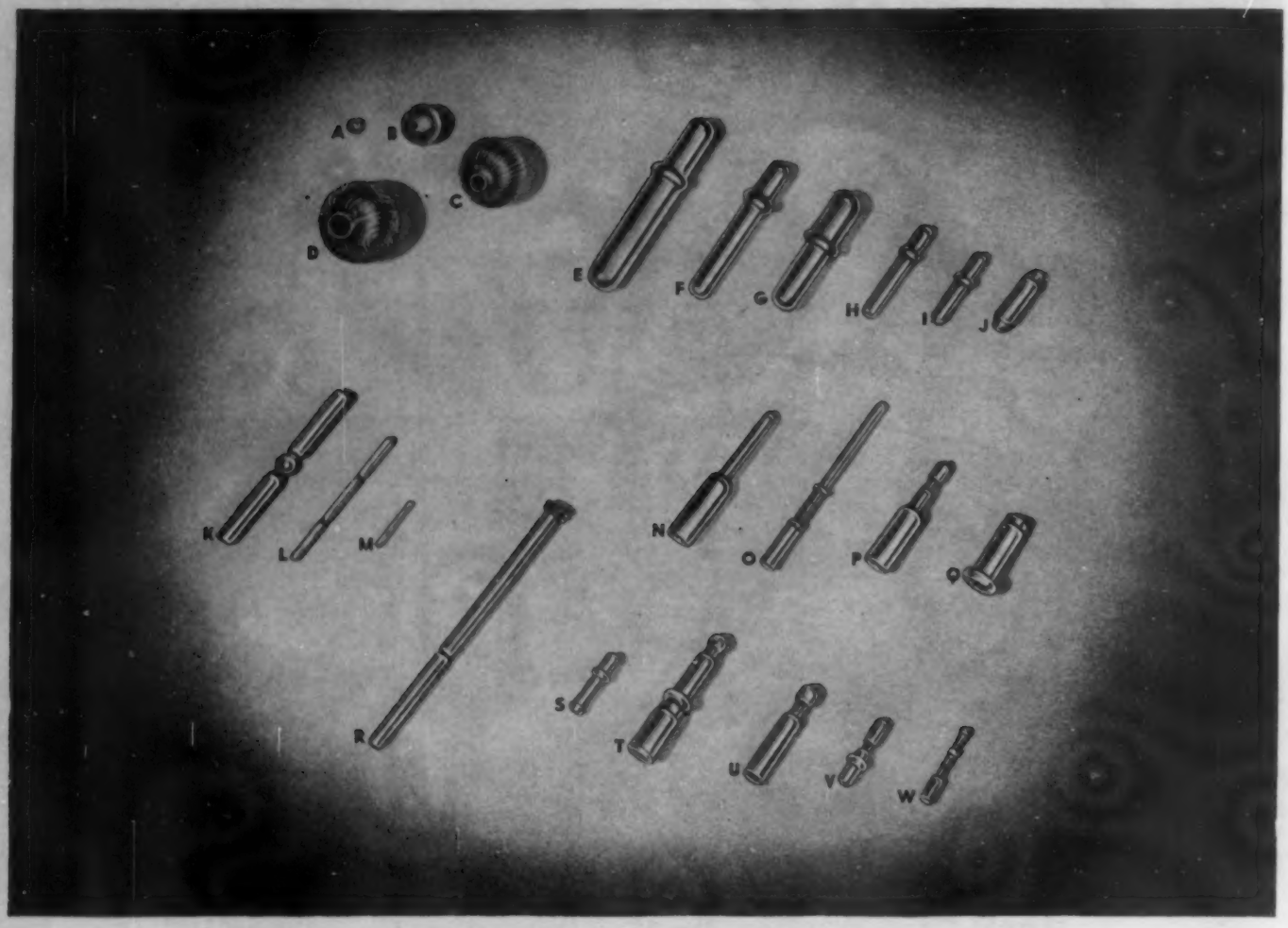
We think we can help you in any of these cases. In any case, we would like a chance.

Sincerely yours,

Charles M. Meeks

Charles M. Meeks
Cost Accountant

MULTI-SWAGE . . . THE MOST ECONOMICAL METHOD OF MAKING SMALL METAL PARTS LIKE THESE . . .



THESE ITEMS, PICTURED ACTUAL SIZE, ARE TYPICAL MULTI-SWAGE PRODUCTS. THEY SHOW THE APPROXIMATE LIMITATIONS OF THE PROCESS AS TO DIAMETERS AND LENGTHS

MULTI-SWAGE is an advanced swaging process which forms hollow or solid parts from flat stock, seamless tubing, rod, or wire, without scrap. Tolerances are maintained accurately and most metals can be worked. Quantity is a factor to be considered. Because MULTI-SWAGE is a high speed process, 100,000 pieces on other than stock items are usually necessary to justify tool and setting up costs. Compare any small parts you use to those shown above. If the nature of the parts and the quantities indicate they can be made by MULTI-SWAGE, it can be well worth your while to consider the BEAD CHAIN MULTI-SWAGE PROCESS.

Send Samples and Specifications of Your Parts for Specific Information

ARMY E NAVY

BEAD CHAIN **multi·swage** PROCESS

BACK THE ATTACK
BUY MORE WAR BONDS

THE MOST ECONOMICAL METHOD OF PRODUCING SMALL METAL PARTS TO CLOSE TOLERANCES WITHOUT WASTE

THE BEAD CHAIN MANUFACTURING COMPANY
98 MOUNTAIN GROVE STREET, BRIDGEPORT 5, CONNECTICUT

How to Make the Best Use of Plastics in POSTWAR PACKAGING

COSMETIC CONTAINERS

Vuepak cartons—Lustron
Resimene

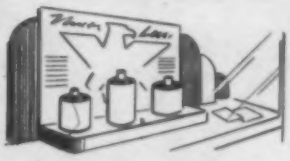
VIALS, BOTTLES

Lustron

CLOSURES

Resinox Lustron
Resimene

WINDOW DISPLAYS



Vuepak sheets
Fibestos sheets

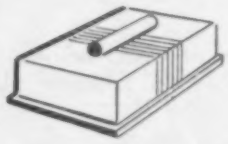
CORROSION-RESISTANT LAMINATES

Monsanto's vinyl acetals

RE-USE PACKAGES

Lustron Resinox Resimene
Vuepak sheets Fibestos

DECORATIVE INSETS



Nitron sheets

COUNTER DISPLAYS

Vuepak sheets Lustron
Resimene Resinox Fibestos

"HELP YOURSELF" DISPLAYS

Vuepak

MONSANTO PLASTICS FOR PACKAGING

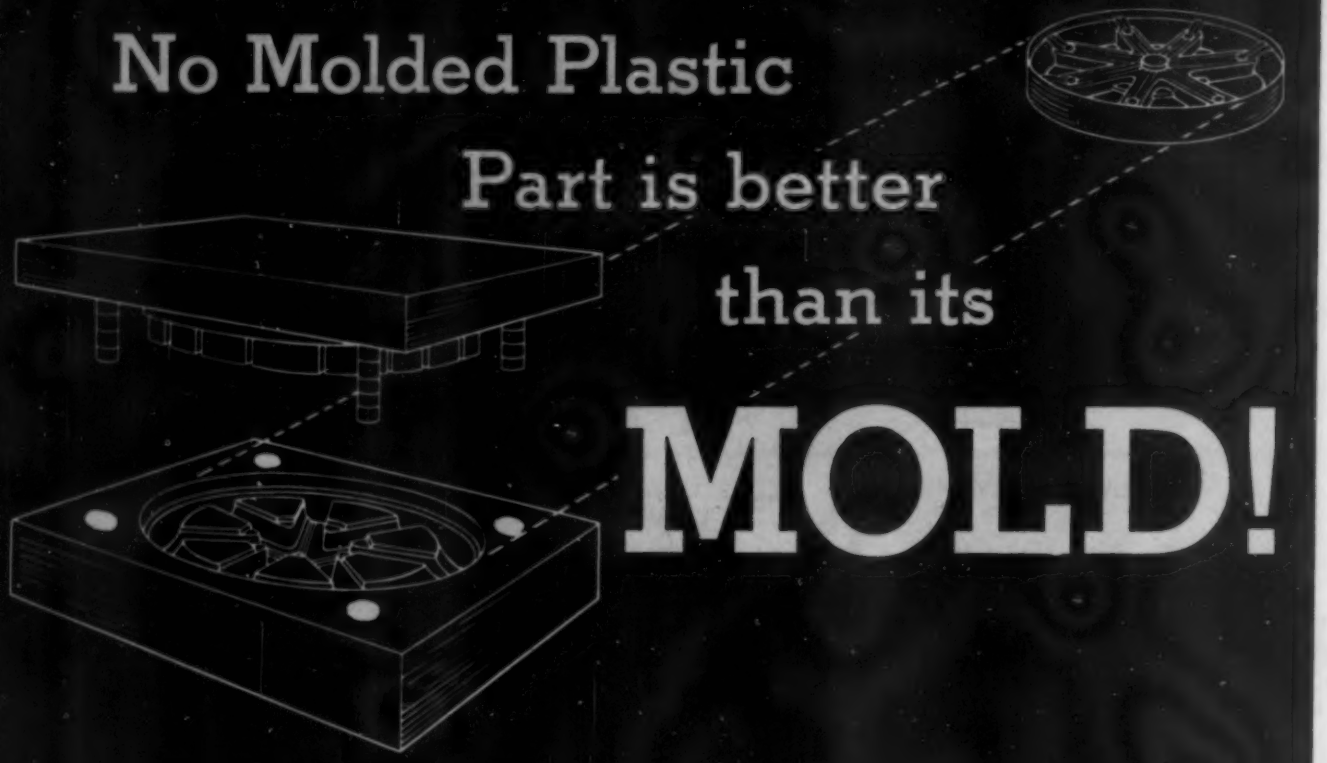
	Tensile Strength	Impact Resistance	Heat Resistance	Strength at Low Temperatures	Dimensional Stability	Color Range	Forms* Supplied	Molding** Methods
FIBESTOS (cellulose acetates)	good to excellent	excellent	to 120—212°F.	good	fair to good	unlimited	MC, S, R, T	I, C, E
LUSTRON (polystyrene)	good	good	to 180°F.	excellent	excellent	unlimited	MC	I, C, E
NITRON (cellulose nitrates)	very good	excellent	to 140°F.	good	good	unlimited	S, R, T	special methods
RESIMENE (melamine-formaldehydes)	very good to excellent	good	to 210—380°F.	excellent	excellent	all but lightest colors	MC, IR	C, T
RESINOX (phenol-formaldehydes)	good to very good	good to excellent	to 230—450°F.	excellent	excellent	darker colors only	MC, IR	C, T
VINYL ACETALS	rubber-like compounds are supplied in both thermoplastic and thermosetting (vulcanizable) forms, are used primarily as fabric coatings and adhesives but can also be extruded in limitless range of colors.							
VUEPAK (cellulose acetate)	good to excellent	excellent	to 120—212°F.	good	fair to good	transparent	S	sheets only

*MC—molding compounds S—sheets R—rods T—tubes IR—industrial resins
**I—injection C—compression E—extrusion T—transfer, form of compression

THIS is just a beginning of the long list of packaging jobs the broad and versatile family of Monsanto Plastics will fill after the war. This chart is only a bare outline of the major properties of the broadest, most versatile group of plastics offered by any one manufacturer. For specific help on *your* problems and specific advice on the best plastic for *your* needs, write: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

MONSANTO
PLASTICS
SERVING INDUSTRY...WHICH SERVES MANKIND

No Molded Plastic Part is better than its MOLD!



THE MOLD is the master pattern which governs the shape, dimensional accuracy, and surface finish of every part that comes out of it. Likewise, the ingenuity with which it is designed often governs the speed and economy of production. It is the most important single factor in the process of plastic molding.

That's why we put so much emphasis on mold-making . . . why we are satisfied with nothing short of perfection . . . why we maintain one of the largest and best equipped mold-making departments in the industry, manned by highly skilled and experienced craftsmen.

We know mold-making . . . and we should, for the men who founded CMPC and are its directing heads today have been designers and builders of molds for a quarter of a century.

That's a good point to bear in mind when choosing your plastic molder. And, remember, too, that CMPC offers a complete service . . . designing, engineering, mold-making, molding, and finishing . . . backed by an organization with over 25 years of experience and the largest, best equipped custom molding plant in the Middle West.

We've been at it for over 25 years

You can get action on your postwar plans . . . NOW!

If you're thinking in terms of plastics for your postwar product, ask for the services of a CMPC Development Engineer. He can be of real help to you . . . by determining what parts can be advantageously molded of plastics . . . by helping in the selection of materials . . . by putting at your disposal the latest wartime developments . . . by suggesting design for most effective and economical results . . . by making laboratory tests, building experimental molds, or building your finished production molds.

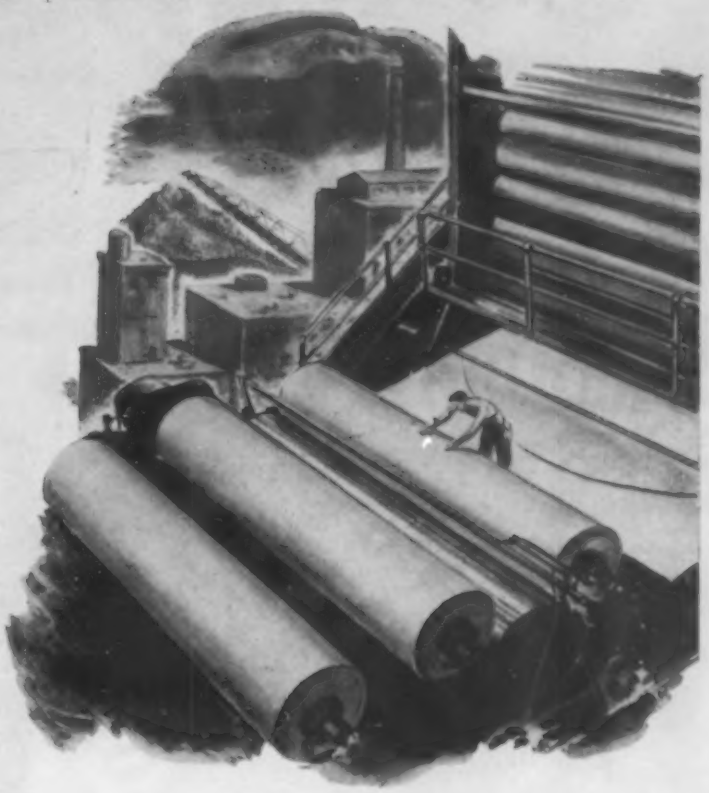
This preliminary work can be done now. Then, when priorities are lifted you'll be in line for production as soon as materials and press capacity are available. Write today. There's no obligation.

CHICAGO MOLDED PRODUCTS CORPORATION

1046 N. Kolmar Ave. Chicago 51, Illinois

COMPRESSION, INJECTION, AND TRANSFER MOLDING OF ALL PLASTIC MATERIALS

Plastics Extrusions FOR A PAPER MILL?



Yes!..

...and perhaps in your business, too!

Why have hundreds of businesses —pharmaceutical houses, electrical manufacturers, barrel makers . . . even a *paper mill*—written to us for detailed information about plastics extrusion machinery. Because they foresee a *profitable use* for this fast, simplified plastics production method in their *individual industries.* And, remember in *your* business, that *same time-saving, money-saving possibility* may exist! For no matter *what* your product, there's a big chance that plastics extrusion can offer one or *more* of these striking advantages:

SIMPLIFIED MANUFACTURING OPERATIONS. *The extrusion of plastics is a simple, continuous operation. Infinite variety of shapes may be speedily, economically produced.*

IMPROVED PRODUCT DESIGN. *The use of extruded plastics parts can make your product more* attractive, *more* effective in operation, *and* cheaper to produce.

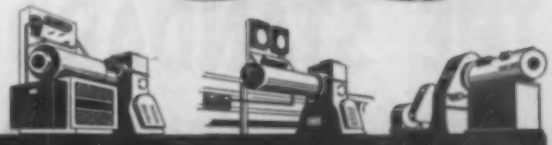
PACKAGE APPEAL. *Extruded plastics containers are* economical *and* highly attractive. *Can give your product* greater sales appeal *and make possible* lower packaging costs.

GREATER MARKETING POSSIBILITIES. *Use of plastics extrusions on a product provides smartness, color, richness of appearance —heightens* sales appeal.

So, look for the hidden possibilities for the use of extruded plastics in *your* business. The illustration to the right gives you an idea of the vast variety of shapes and forms produced by this method. For further information write to America's leading maker of plastics extrusion machinery.

Why not plastics extrusions for post-war home construction . . . for trim, molding, air ducts, electrical conduit, lighting fixtures, and scores of other uses where the beauty, ease of clearing, and durability of plastics extrusions would be desirable.

Plastics Division
EXTRUSION MACHINERY

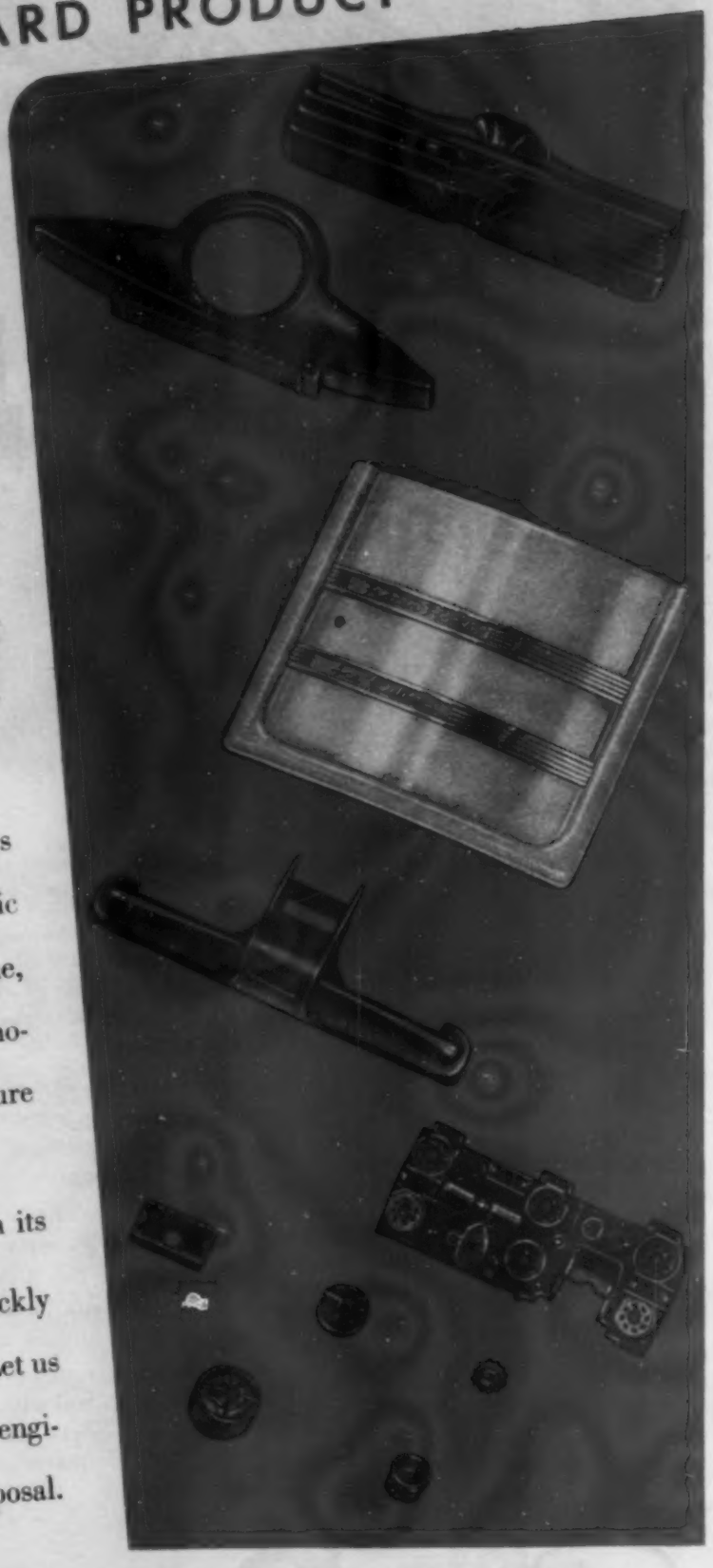


NATIONAL RUBBER MACHINERY COMPANY
General Offices: Akron 11, Ohio

IT'S A STANDARD PRODUCT

Plastic

MOLDING SERVICE



Through years of experience, the Standard Products Co. has acquired a wealth of knowledge in the art of molding plastics. Standard offers complete molding service.

Standard's molding equipment is capable of producing items of phenolic cellulose-acetate, butyrate, polystyrene, ethocel and other plastic and thermoplastic materials. These facilities assure perfection in the molding job.

The Standard Products Co., with its great resources, can do your job quickly and effectively at moderate cost. Let us have the necessary data and our engineers will submit designs and proposal.

THE STANDARD PRODUCTS COMPANY

General Offices and Research Laboratory

505 Boulevard Bldg. • Woodward Ave. at E. Grand Blvd. • Detroit 2, Mich.

HATS . . . off to the Tropics!

Old Sol isn't going to be the "undoing" of any American fighting men in the tropics, if first-class tropical equipment can prevent it. Sun helmets are important in tropical areas and must reach destinations undamaged. In their delivery, H & D corrugated shipping boxes are completing another wartime packaging mission—without a hitch.

Every H & D war packaging project is minutely studied by H & D Package Engineers to determine if it holds any features that may assist in bettering the packages you will use when world commerce is again on a peace-time basis. Already the "early birds" of progressive business are *getting a line* on future packaging requirements; planning and designing *now* so they won't have to *stand in line* later.

The files of H & D are crowded with packaging ideas obtained from hundreds of war-time jobs. So, for packages that will protect and promote your products, remember, H & D Package Engineers are ready to help you plan *now*.

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MODERN PLASTICS
DECEMBER 1944 VOLUME 22 NUMBER 4

Hobby lobbying

Plastics are rapidly becoming the favorite handicraft material for both the amateur and the professional hobbiest. This trend is evidenced by what goes on daily at the U.S.O. hobby shops in Chicago where more and more servicemen and women are selecting plastics for their handiwork. If Lewis Utley has his way, the war will not bring an end to this trend. Taking his own home workshop experience as an example of the results that can be obtained with a minimum of equipment, he hopes to be of assistance to returning servicemen who want to set up similar workrooms.

A PREVIEW of what may easily become one of the nation's liveliest and most interesting hobbies after the war takes place almost every day in the handicraft shops of the U.S.O. servicemen's centers in the Chicago area. In these shops can be found soldiers and sailors on leave—sometimes even WACs and WAVEs—hard at work on their favorite craft. Some will be working in wood; others in leather, clay, cork or bone. A few will be making Commando knives or other objects of metal. Here and there a more enterprising serviceman may be grinding and polishing semi-precious stones. Some will be experts in their particular lines; others only beginners.

But on evenings when the hobby shops are crowded, more servicemen will be found working in plastics—now the most popular hobby of all—than in all the other materials combined. The growth of this new plastics hobby in the U.S.O. centers has been both rapid and steady during the last few months. Its only limit so far, according to Chicago U.S.O. officials, has been the availability of plastic materials, most of which is scrap donated, purchased or salvaged by the servicemen themselves from a wide variety of products made of plastic or containing plastic; even discarded "juke" boxes and dismantled airplanes are completely stripped of their transparent plastic parts.

There is ample evidence that working in plastics in the U.S.O. shops is by no means a fad or passing fancy. Servicemen with a few leisure hours have found the work both easy and fascinating with almost unlimited possibilities in the range of objects that can be made with a few simple tools, bits of plastic material, some transparent cement or acetone, an oven or pan of hot water, and perhaps some dye or other decorative substance. Moreover, the craft is quickly learned—so quickly, in fact, that many men with only an evening to spare and no previous experience have received a few pointers from U.S.O. shop instructors and then completed some simple object such as a letter opener, a small picture frame, or a piece of ornamental jewelry before closing time.

Plastic objects so far turned out in the Chicago area shops, all fashioned from scrap thermosetting or thermoplastic materials in sheet, block, rod or tube form, include book ends, buttons, belt buckles, rings, pins, pendants, bracelets, jewel boxes, napkin clips, candlesticks, identification tags, cigarette cases, playing card holders, and even covers for autograph albums. In one U.S.O. center in downtown Chicago, which has a camera shop as well as a hobby shop, a popular evening's entertainment consists of a serviceman's being photographed and then making a suitable plastic frame to fit the picture.

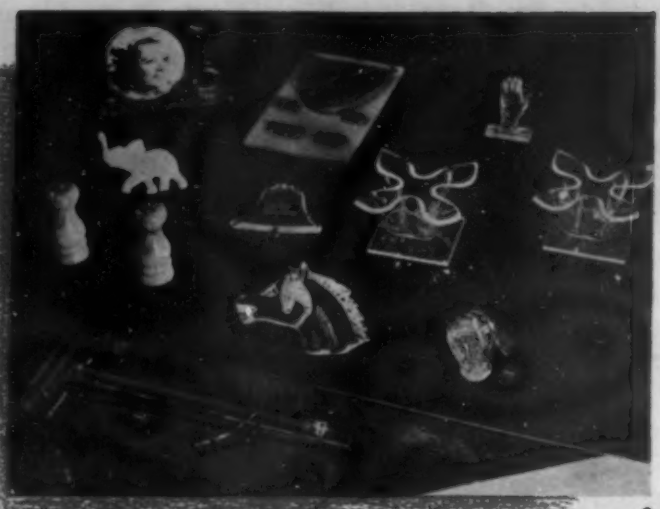
All in all, there are twelve U.S.O. centers in Chicago and the region extending north along Lake Michigan to Waukegan, Ill. This includes shops at such military and naval establishments as Fort Sheridan and the Great Lakes Naval Training Center. Of these twelve, half have handicraft shops with equipment for working in plastics. At the centers in Chicago proper, facilities are maintained for servicemen who may be traveling and have only a few hours to spend on a craft project. More elaborate equipment and larger shops are to be found in centers close to permanent camps or training establishments where men may spend several evenings on the same project and prefer to do more detailed work. One of the best known of these larger workshops is the center at Highwood, Ill., which is close to Fort Sheridan and where, thus far, an estimated 10,000 servicemen (and women) have engaged in plastics work alone.

The Highwood U.S.O. handicraft shop is fully equipped with work benches, lathes, jig saws, drills, and buffing and grinding wheels. Operated under the supervision of the Salvation Army, one of the U.S.O. agencies, it is in the charge of Salvation Army Major Ira Fitzpatrick, himself a hobby and handicraft enthusiast of long standing. He has supervision of instruction in the shop and is assisted by businessmen of the community who volunteer their services.

When the plastics hobby first "took hold" some time ago, practically the only materials available at Highwood were of the thermosetting type. This, of course, imposed limitations on what could be produced. Later, when more of the thermoplastics became available, interest in the craft quickened instantly, with the servicemen taking a keen interest in the bending, forming and shaping of various objects. Today, transparent materials are the most popular.

A serviceman visiting the center and indicating his desire to make a plastic object for himself or as a gift, is supplied with the material without charge, and given patterns or a similar object to guide him. Then, he is shown how to cut the material with a jig saw, how to file or grind it, finish it with two grades of sandpaper and, finally, to buff and polish

1



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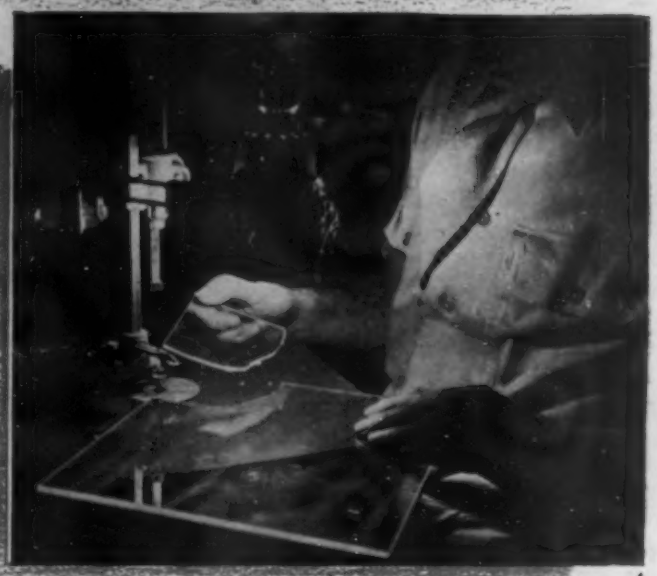

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1 and 2—Picture frames, letter openers, napkin rings, candlesticks, salt and pepper shakers and costume jewelry are typical of the plastic articles that are turned out by servicemen and women in the U.S.O. hobby shops in Chicago. 3—Soldiers new at handicraft work frequently copy an item made by an older worker or an instructor—in this case a pin in the shape of a horse's head. 4—After the design has been etched on a sheet of transparent plastic, a jigsaw cuts this section free from the rest of the strip to facilitate the engraving and finishing work

it. If more than one part is involved, he is shown how to use cement or acetone as a bonding agent. If forming is required, he is made acquainted with an oven or the procedure for using hot and cold water to shape the plastic.

The ease with which objects made of wood can be duplicated in plastics greatly simplifies instruction. Many servicemen, however, have their own original ideas or inspirations that stem perhaps, from objects they have seen in the stores. These men and women are encouraged to use their own ingenuity and judgment. In fact, the difficulty of obtaining materials has put something of a premium on ingenuity. Once, when little was at hand, a serviceman found himself with a solid rod of plastic approximately $1^1/_2$ in. in diameter, and promptly decided to make a pair of salt and pepper shakers. These were fashioned on a lathe, and the inside of the tube drilled out for cork stoppers. In another instance, a serviceman made an attractive salad bowl, using the dome of an old "juke box." Base and legs of the bowl were formed from other scrap materials.

Recently, the servicemen craftsmen have been expressing a desire to engrave and decorate their products. For this they use the same tools available for woodworking plus a set of dental drills, or burrs.

While it is true that many of the men visit the shops only to "pass the time" and perhaps make a locket or bracelet for some faraway sweetheart, there is every indication that the work of the servicemen is laying a firm foundation for substantial growth of the plastics hobby in the postwar years. A surprisingly large proportion of the men are keenly and sincerely interested in the craft, U.S.O. officials say, and many requests have already been received from men stationed overseas who want materials with which to continue the work as a hobby or, in some cases, as a remunerative venture.

Another reason plastics enthusiasts have for predicting that their hobby will be a major one after the war is the appeal it has for women. In addition to the WACs and WAVEs who have become interested in working with this material, many wives of servicemen have taken up the hobby. That

the hobby also is making rapid civilian progress is shown by the activities of the civilian instructors, most of whom had never heard of plastics handicraft until they volunteered their services to the U.S.O. These men have quickly learned the "art" and some say they are teaching it to their neighbors.

A large number of the servicemen report that plastics craftsmanship is spreading rapidly everywhere in the Army and Navy, lack of materials being the only deterrent. Almost every day in the U.S.O. at Highwood center, men say they already are making plans to engage in the hobby on the same scale as do enthusiasts in woodworking and carving and in other established crafts. Men with home workshops are especially determined to follow up the idea after the war while novices are attracted by the fact that no special tools are necessary for this type of work.

Complementing the work of U.S.O. hobby shops are the plans which even now are being formulated by those at home to make it possible for our servicemen and women to continue this plastics handicraft work in the years following the war. One of the most active proponents of this work is Lewis Utley who is convinced that we can look forward to the greatest resurgence of crafts activity that this country has ever known. Mr. Utley bases his prediction on the fact that this is a mechanized war in which every man has acquired some skill with his hands. While each soldier can be expected to make a beeline for home once he has received his honorable discharge, with the full intention of just sitting and sitting for a long, long time, it won't be long before his hands will have an overpowering urge to be doing something.

In addition to these able bodied ex-soldiers who *want* to stay home yet need some outlet for their energies, there will be other men who will be *forced* to restrict their activities. For both groups, home workshops offer interesting work, well within the capabilities of the members. Add to these men the thousands of others who will be urged to take up crafts work by their doctors as a treatment for nervous and mental ailments, and you have a basis for a movement that will run into the millions. (*Please turn to next page*)

***5**—Opaque heart-shaped lockets in a variety of colors are polished by the servicemen before they are strung. **6**—Dentist burrs are frequently used in the U.S.O. centers in Chicago in place of portable drills. **7**—Narrow strips of transparent acrylic sheet are heated in portable ovens preparatory to forming. **8**—Shaped around a short length of tubing, this half circle of plastic sheet material will be used by this soldier on a picture frame*

9 and 10—Many of these jewel-like articles, made in Lewis Utley's home workshop, have served as models for quality merchandise. In his handbag clasps, Mr. Utley achieves a bubbling diffusion of color by partially routing the plastic from inside the rod and applying the dye to the two end pieces that are attached in a finishing operation. **11**—*Many of the tools in this basement room have been altered by the addition of ingenious gadgets which permit one machine to do the work of many.* **12**—*A band saw of Mr. Utley's cutting a plastic sheet to size*

When Mr. Utley says that there isn't a single crafts process that cannot be used in connection with plastics just as easily as with any other medium, he speaks from a lifetime of experience with craft work. While other youngsters looked to newspaper routes and errands for spending money, young Lewis bought himself a pyrography outfit and a set of paints. Soon he was hawking a variety of etched wood and leather articles throughout the neighborhood. This and other work in handicrafts led to the establishment of a novelty business after his graduation from school. By 1915 he was in Chicago organizing the Molloy Co. and developing a Super-finish process, a combination of embossing, airbrushing and finishing, which gives leather that antique appearance so highly regarded in the bookbinding and arts gift field.

Five years later Mr. Utley joined the Fabricoid Div. of E. I. du Pont de Nemours and Co., Inc., devoting his time to the devising of thousands of ingenious ways of using the company's coated fabric. In succeeding years with this same company—until his request for a leave of absence in July 1944—he has had occasion to use every craft technique—painting by handbrush and airbrush, lithography and enameling, embossing and tooling, applique and cutout.

The Utley workshop is in the basement of his home—a room about ten by twenty feet, clean and compact with every inch efficiently utilized. There are power lathes, saws, drills and jigs, a small compression press, racks of dyes, cement, acid. And in neat bins along one wall, there are rods and tubes, sheets and blocks of plastic materials—transparent acrylics for the most part. Nor are all the tools standard "store-bought" devices. Many are ingeniously contrived gadgets

that permit one machine to do the work of many or to do its own particular job more efficiently.

As he talked of his years of experience with handicrafts, Mr. Utley continued work on a gleaming, gracefully tapered vial, somewhat in the Swedish mood. It was the model of a new container he is designing for a well-known perfumer. It is seldom that Mr. Utley uses drawings in his work; he prefers to design right on the la he.

"There's no more satisfying medium in the world than the acrylics. Working with transparent materials seems to add a fourth dimension to the piece in hand. The clear pieces give a kind of x-ray vision. There's a modern clean look about them and they're fun to work with."

In illustration, Mr. Utley took up a small transparent block, about an inch thick. The table saw was set to make a quarter-inch cut, and the block was held against it. Through the top a clean groove could be seen—cut into the under side. Mr. Utley made a few parallel grooves, then others at different angles, and a new geometrical pattern took shape.

But the expense? Wouldn't the cost of the necessary tools and equipment put a home workshop out of the reach of the average serviceman?

"You don't need all this equipment, certainly not to start with," Mr. Utley said. "Any one of these machines I now have can be adapted to do the work of all the others. Maybe not so easily, or over so wide a range, but satisfactorily. Why, there are hundreds of items you can make with a small jig saw and a few adapters. With an expenditure of $25.00, you can be all ready to go to work. What's more, if you've any ingenuity at all, you can sell the (*Please turn to page 200*)

13, 14, 15 *and* **16**—*Over the years, Mr. Utley has built up his workshop until it contains every type of tool that could possibly be of use in his handicraft work. However, it is his opinion that hundreds of articles can be made using nothing but a small jig saw and a few adapters. A beginning can be made with an expenditure of about $25*

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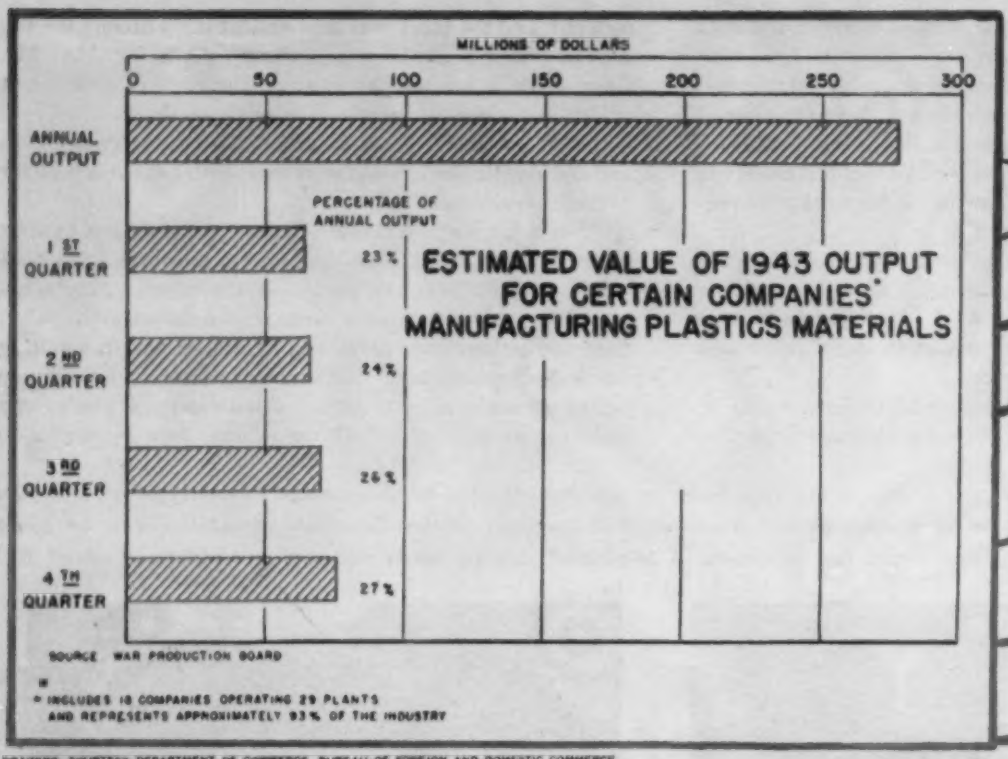

DRAWING, COURTESY DEPARTMENT OF COMMERCE, BUREAU OF FOREIGN AND DOMESTIC COMMERCE

Plastics markets in Latin America

WITH production of plastics raw materials stepped up and the productive capacity of molders, fabricators, extruders and laminators considerably enlarged to meet military and war production requirements, the United States' plastics industry is taking stock of possible postwar outlets for its goods. Many firms are looking toward foreign as well as domestic markets as potential consumers of both raw materials and finished products. To assist in this charting of the future, MODERN PLASTICS has made a survey of the South and Central American countries as postwar customers for North American producers of plastics.

"Latin America holds not only promise but actual business for the United States' plastics industry." This is the conclusion of several experts in the field, men who have spent many years gathering data and establishing business relations with South and Central American countries. It is a judgment upon which they are projecting their own future business activities.

Before the war, the United States' plastics industry was not particularly export minded. Little business was done with firms south of the Rio Grande. In the main, Latin Americans imported the plastics they required from Germany, Japan and the United Kingdom; relatively small quantities from the United States. Comparatively, United States' prices were higher and business terms too restricted to appeal to our Southern neighbors. Too, Latin American business methods were different, and North Americans seemed unable, at that time, to meet the language difficulties, long-term credit requirements and other conditions peculiar to selling in these countries.

The war has changed all that. Now, such plastics as are imported—and none of our Southern neighbors manufactures enough raw materials to meet its requirements—come largely from the United States. The reason is that this country is, at the moment, the only one with the raw materials, the shipping facilities and the dominance of sea lanes necessary for extensive overseas trading. England exported southward until the early part of 1944.

Whereas in 1937, a normal prewar year, the total United States' world export of 3 important types of plastics amounted to $2,500,000; in 1940 this figure had more than doubled, reaching $5,200,000. By 1941 the value of these plastics exports had increased to $7,295,000.[1] Before the war, a large portion of these materials went to the United Kingdom, France, Austria, Germany and the Soviet Union; currently, a greatly increased share is going to Latin American countries.

Latin American countries producing their own plastic materials, either wholly or in part from local raw materials, are Argentina, Brazil, Chile, Colombia, Uruguay.[2] Peru, Venezuela and Cuba manufacture no raw plastics but do produce some finished plastics from imported materials. While Mexico has facilities for producing phenol-formaldehyde and alkyd resins, those materials must now be imported owing to the lack of raw materials. "Mexico has facilities for producing finished goods from both thermoplastic and thermosetting materials . . . and after the war . . . the demand for plastics materials should expand very rapidly.[3]" The favorable labor situation, plus land-proximity to the United States, have led at least two North American companies—Foster-Grant Co. and New England Novelty Co.—to establish plants in Mexico. It is rumored that other large producers are contemplating such establishments after the war to serve both Mexico and the United States.

[1] Cooling, B. F., "Plastics and Plastics Materials—Post-War Foreign Markets: Latin American Potentialities." Foreign Commerce Weekly, U. S. Department of Commerce, Washington, D. C. (April 22, 1944).

[2] Types of materials manufactured (no quantity figures available): Argentina—casein, alkyds, phenol-formaldehyde; Brazil—phenol-formaldehyde, casein, cellulose acetate, "Ebonite" (rubber compound); Chile—casein; Colombia—phenolic resins; Uruguay—casein.

[3] Phillips, Susan M., "Latin American Plastics Industry and Trade." Inquiry Reference Service, U. S. Department of Commerce (May, 1944.)

Other importers of plastics in extremely small quantities are Ecuador, Costa Rica and Paraguay. None of these countries possesses the facilities necessary for molding—the materials being used in paints and coatings, and for a wide variety of fabricated articles. About half the Latin American Republics neither manufacture their own plastics materials nor fabricate semi-finished forms of plastics. These countries include Bolivia, the Dominican Republic, Guatemala, Haiti, Honduras, Nicaragua, Panama, Puerto Rico and El Salvador.

Actual figures on total consumption of plastics in Latin America are not available. However, estimates place the amount of synthetic resins consumed in Brazil in 1941 at 1,749,000 pounds. In a "normal year" Mexico uses about 2,000,000 lb. of all plastics materials, Uruguay has an annual consumption of 330,000 lb. and Cuba a yearly average of about 80,000 pounds. In 1941 Argentina, whose consumption of materials has been governed almost entirely by imports, purchased 2,574,000 pounds. Although these are the most reliable figures presently available, they are somewhat misleading to North American readers because of the different categories into which plastics are divided by Latin Americans. On this basis, one responsible business source estimates that the figures appear to be about 50 percent too high.

An authoritative estimate states that there are approximately 500 compression presses and 90 injection presses below the Rio Grande. Injection sizes are smaller than in the United States, varying from 10 gms. to 8 oz.—the majority being close to the 10 gm. size which is equivalent to less than $\frac{1}{2}$ of one ounce. Plans for postwar expansion of the molding business revolve for the most part around automatic injection equipment and automatic and semi-automatic compression presses. Some mold making is now done locally. Before the war, many molds were imported from the United States, but with the shortages of material and manpower in this country, Latin Americans were thrown on their own resources and have developed, according to one observer, a creditable capacity and skill for making their own molds.

As new machinery is bought and installed, the import picture for raw materials will change. At present, the balance is heavily on the thermosetting side, with phenolics leading the field. As injection equipment becomes more established, thermoplastics will move up in volume.

The general postwar situation in South America looks very good from an economic viewpoint. According to B. F. Cooling of the Bureau of Foreign and Domestic Commerce, "with a population comparable to that of the United States and a territory about two and one-half times as large, Latin America is commencing to forge ahead industrially and economically. A higher standard of living is a natural corollary to this expansion, and plastics may well offer a powerful stimulant to this advancement.

"There is an enormous field in Latin America for plastic bonded plywood and other laminations, for pipe and tubing, for a thousand and one molded thermoplastic and thermosetting plastic building materials. Phenolic resin manufacturers, who are working with architects and builders in planning the houses of tomorrow, visualize a bright future.

"Civilian demands for consumer goods in Latin America are large now and are constantly increasing. This nascent desire for luggage, hats, textiles, jewelry, pottery and novelties, together with the many demands in the building and transportation fields, should afford our industry expanded trade outlets for plastics products and plastics raw material.

"The degree to which plastics are gaining acceptance in the various American Republics is dependent upon the degree of industrialization of each individual country . . . . This does not mean that the less industrialized countries do not offer a very considerable potential market for finished molded products."[1]

There is no country in Latin America that has not built up a substantial dollar-volume in purchasing power. Since our entrance into war, the United States has bought from all of these countries much more than it has sold to them. As a result all have excellent cash balances—the kind of balances which make for a sound financial trading basis. Business conditions between the two Americas promise to be very different from those that existed prior to the war when, for example, a United States press manufacturer found himself in competition with a German manufacturer who was giving as much as two years of credit. Less difficulty was encountered in the marketing of raw materials which, today, comprises a large segment of American plastics export. Latin American plastics manufacturers are buying as much material from the United States as they are allowed to purchase.

There is apparently not much of a custom molding market in any South American country. By and large, present and projected molding facilities are more than ample to handle local custom molding requirements which, at present, are small except in the highly industrialized countries of Argentina and Brazil. In addition, each country is an economic entity with tariff barriers that prevent the custom molders in one country from doing work for industries in another. The net

TABLE I—UNITED STATES EXPORTS OF PLASTICS MATERIALS TO LATIN AMERICAN COUNTRIES[a]

Country and commodity	1937 Pounds	1937 Value	1940 Pounds	1940 Value	1942 Pounds	1942 Value
Cellulose acetate (sheets, rods or tubes):						
Argentina	1,359	$ 429	64,043	$36,188	176,600	$94,433
Brazil	209,950	73,018	232,387	82,682	143,060	68,960
Chile	6	16	4,448	2,662	32,404	16,601
Colombia	84	64	18,014	8,906	121,201	55,689
Cuba	3,269	2,158	9,370	5,978	11,504	6,094
Mexico	905	667	26,408	14,019	402,264	184,129
Ecuador	....	....	....	....	8,288	2,303
Venezuela	41	75	15,951	8,641	11,556	5,571
Total	215,614	76,427	370,621	159,076	906,877	433,780
Pyroxylin (sheets, rods or tubes):						
Argentina	141	124	13,938	11,295	173,860	216,637
Brazil	1,295	1,351	8,572	7,892	79,537	67,032
Chile	1,819	1,184	2,757	2,297	6,042	5,061
Colombia	1,936	1,312	5,570	4,892	13,405	9,186
Cuba	5,128	3,729	10,522	5,596	5,333	4,366
Mexico	1,485	966	2,668	2,006	16,809	18,204
El Salvador	....	....	6,693	3,956	12,916	7,139
Uruguay	464	674	833	515	6,165	5,980
Venezuela	665	937	1,423	1,558	11,315	9,488
Total	12,933	10,277	52,976	40,007	325,382	343,093
Synthetic gums and resins:						
Argentina	117,902	19,658	980,621	164,842	676,495	182,281
Brazil	143,329	47,867	230,557	66,308	190,652	59,391
Chile	1,330	186	220,406	57,630	201,545	56,694
Colombia	3,901	1,850	34,247	18,017	13,768	4,370
Cuba	10,163	1,415	97,747	36,704	55,935	32,350
Guatemala	....	....	....	....	1,437	726
Mexico	123,821	32,201	432,369	110,292	219,644	57,980
Peru	9,957	623	41,903	6,021	11,191	2,730
Uruguay	4,277	390	107,726	21,052	53,923	21,418
Venezuela	1,699	160	30,832	12,365	17,351	5,991
Total	416,379	104,350	2,176,408	493,231	1,441,941	423,931

[a] The article "Plastics and plastics materials" which appeared in the April 22, 1944, issue of Foreign Commerce Weekly is the source of the information presented in this table.

result is that the demands of industry for plastic parts are not large enough to warrant molders investing in costly molds.

The real market for finished products is either in the very inexpensive categories—plastics combs, hair ornaments, jewelry, etc.—or in the very high quality group of products where plastics may play a contributory or subsidiary part. Thus, North American molders interested in producing for the Latin American market might well concentrate upon inexpensive, mass-produced proprietary items.

The selection of marketing methods to be employed in South American countries would seem to depend, to some extent at least, on the size of the projected operation. Probably few molders will want to set up their own export department, preferring to utilize the existing offices of an established exporter. Under such an arrangement the molder would give samples, models and literature to his exporter or to his own Latin American agents. The agents would act like jobbers, taking the molder's samples to prospects, collecting orders, transmitting instructions, arranging credits and seeing that bills were paid.

The agents would advise the molder on packing his orders for overseas shipment, a procedure with which more and more molders are becoming familiar under wartime necessities. They would also keep the molder informed regarding tariffs—an important service since Latin American import duties vary considerably. In most instances, these tariff laws are not based on the United States' principle of protection for home industries, oftentimes being highest where no comparable industry exists. It is the practice of some South American countries to rely on customs duties for the major portion of their governmental budgets.

In dealing with any foreign market, the political climate must always be considered. Latin America has many political upheavals, which sensitive on-the-spot observers can sometimes detect early enough to avoid business losses.

Although Latin American countries are, by and large, still not fully developed, the trend is one of advancement. In addition to making strides politically toward completely democratic rule, they are also making industrial progress. One of the best examples is Mexico. In this country industrialization has also proceeded with leaps and bounds. The encouragement that the government gives to industry coupled with a rising standard of living for the masses is creating a market large enough to absorb the output of new plastics plants, making the establishment of such operations profitable. A case in point is the recently organized "Plasticas de Mexico" which will manufacture resin-impregnated plywood, cloth and paper articles molded by fluid pressure.

It might be possible, by introducing North American plastics' experience into such (*Please turn to page 206*)

ALL PHOTOS, COURTESY GENERAL PLASTICS CORP.

1—The high-altitude oxygen mask for the Armed Services has gone through many stages of development. The mask at the left is an early model, painted white for use in the snow. The latest experimental model, which is mounted on the typical head form, is of full helmet type. One of the two early models shown at the right was made of transparent sheet stock for study. Using smoke, it is possible with this mask to observe the flow of air or oxygen

Molding of thermoplastic sheet

VAST possibilities in the field of molding, forming, shaping and fabricating sheet thermoplastic materials are being unfolded as new and unusual examples of precision results and intricate workmanship come to light.* This work with thermoplastic sheet has been called the "Fourth process" by some members of the plastics industry—the other three being injection and compression molding, and laminating. Proponents of this phase of plastics production predict that the molding of thermoplastic sheets soon will assume a dominant position in the industry because it is based on the same manufacturing fundamental that has led to the fabrication into sheets of such a huge percentage of all the metal that is processed.

However accurate this forecast may be, the work now being done in the field is not only interesting in itself but indicative of the rapid and important progress that has been made—much of it achieved since the start of the war. An excellent picture of just what is being accomplished is obtained in a review of some of the recent activities of a large midwestern molder which extend in several different directions and range all the way from intensive experimental work on high-altitude oxygen masks for the Army Air Forces and Naval Aviation to the standard production of lighting fixtures, scientific display boards, display models, fire extinguishing equipment, safety equipment and scores, if not hundreds, of other products.

Based on an exclusive method originated and patented by the president of this company, work is being carried out in both rigid and semi-rigid thermoplastic sheets that vary in thickness from five-thousandths to 375 thousandths of an inch. Materials include acrylic, methyl methacrylate, vinyl chloride resin and polystyrene sheet, and other plastics will be used as they are developed and made available in sheet form also.

Basically, the process divides itself into three parts—the treating, heating and molding of the thermoplastic materials as they are supplied in sheets or rolls, with an unrevealed "double treating" method forming the keystone of the process. Several different types of dies are employed, designed and constructed in accordance with the requirements of the specific problems of a given application.

High-altitude oxygen masks

High-altitude oxygen masks represent some of the best current examples of the possibilities of the process. Working closely with the Armed Services, the molder has carried the masks through many stages of development and experimentation, beginning at the time when serious rubber shortages threatened to develop in this country. In its latest experimental form, the mask is of full helmet type (Fig. 1) designed for the Army Air Forces and Bureau of Aeronautics, Navy Dept. The first part, which is molded in one piece, forms the exterior covering for the forehead and lower face, and includes a transparent lens or window. The second part forms the front inner chamber of the mask, including the inhalation and exhalation valves, and various channels and chambers. This also is molded in one piece. The third and fourth moldings are the left and right head coverings which accommodate the ear phones.

In the complete assembly, a zipper is installed between

2

the head coverings so that the mask can be put on and removed. Visual and breathing cavities are sealed with specially treated sponge rubber, and the entire unit is lined with lamb's wool. Incorporated in the assembly is the oxygen inlet which is made of extruded tubing. A sun or weather visor, made in different colors, may be added to the unit. Finally the entire helmet is painted olive drab, in camouflage colors or white if a "snow color" is desired.

The materials used throughout the entire mask, including oxygen inlet and visor, is ethyl cellulose. It is reported that this plastic was the only sheet material with sufficient flexibility under test at −70° F., although several others are said to hold promise in similar cold applications.

The mask is of the "demand" type which means that its wearer obtains sufficient oxygen through the natural action of his own respiratory system. The oxygen first passes through two channels—one on each side of the face—and crosses in front of the lens or eyepiece, dislodging frost which might accumulate at low temperature. Then the oxygen passes through the visual chamber and two apertures on either side of the nose to two inhalation valves, and thence into the breathing chamber. On exhalation, the exhalation valves under the wind breaker in front of the intake open. As they close, the inhalation valves open and the entire respiration process is repeated.

A navy mask

Another smaller mask, developed by the same process in conjunction with Bureau of Aeronautics experimental work, is used inside regulation flying helmets. It consists of two major assemblies—a larger "windshield" which is fur-lined to retain heat and an oxygen unit which fits inside. The shell of the oxygen unit is in two layers, bound together with an air space between to increase the thermal insulation. Including these two layers, six pieces make up this assembly —five are molded from sheet stock and the sixth, the intake valve, is extruded tubing. Again ethyl cellulose is used throughout the mask.

Back of the experimental work on the masks lies one of the most interesting studies ever undertaken by the Army Air Forces. The purpose was to determine the "average" men of the Air Corps so that their measurements could be used in designing masks, items of equipment and clothing, seating arrangements in planes, locations of instruments and guns, and accommodations in gun turrets. The first step was a large-scale anthropometric study by trained anthropologists at Wright Field during which the measurements of more than 3000 cadet pilots at Kelly and Maxwell Fields were recorded. Head sizes were carefully tabulated and the result were classified into seven typical models which represented 98 percent of the men.

Using facial measurements—root of nose to top of chin,

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2—Left and right head coverings on the latest Army experimental oxygen mask are held together at the back with a zipper. 3—A smaller oxygen mask has been developed for the Navy and is designed to fit inside the regulation-type flying helmet

4—This newly developed process of molding thermoplastic sheet promises to have wide application in the lighting fixture field. **5**—*Other civilian items that have been formed by this process are a transparent display bust, black industrial goggles and a top for a toilet combination*

length of nose, eye spacing, size of ears and shape of chin, for example—G. W. Borkland, president of the molding company, created standard head forms. Life-size plaster heads were made of all the "average" types, including narrow, long and the "most common face" which was Type I.

This type, which was most frequently employed in the oxygen mask experiments, is shown in Fig. 1 wearing the latest high-altitude oxygen mask model. This head has a measurement of 4.8 in. from the root of the nose to the tip of the chin. All of these head forms have been used in designing flying equipment—goggles, helmets and special flying caps in addition to the oxygen masks.

Throughout this development work which led to the molding of life-size articulated cellulose acetate figures,[1] the molding company worked in close cooperation with the Air Forces. These widely publicized manikins have been the standards for the design of much Army Air Forces equipment and have been the basis for important changes in aircraft construction which have increased the efficiency of operation, and the comfort and convenience of pilots and crews. For example the manikins have aided in the correct installation of hundreds of equipment items which involve proper eye level, adequate elbow room and seats of serviceable width.

Civilian applications

That these manikins already have led to civilian applications of sheet thermoplastic molding is shown by recent work of this midwestern molder in developing and producing dress and display models of the human form. The example shown in Fig. 5 is one of the first production models that are now being delivered to retail stores throughout the area. It is molded of 0.080-in. thick, transparent methyl methacrylate sheet material.

Other applications of the process (Fig. 5) which have obvious peacetime application include a black acetate top for a toilet combination. This part is now being used on ships where weight is an important consideration. A wide variety of shields for fluorescent lighting fixtures are molded of vinylite sheet by this method. Methyl methacrylate sheet is used in the molding of industrial goggles while cellulose acetate is employed for the cover of display cases in which scientific specimens are placed for protection.

In the field of war applications this process is used for blisters and windows on planes and gliders, clinometers for the Navy, insulators for electrical equipment, and shatterproof glazing for Merchant Marine lighting fixtures.

Credits—Material; Oxygen masks, Ethocel; Articulated figures, Fibestos; Plastacele; Display model and goggles, Lucite; Lighting shields, Vinylite; Ethocel; Toilet top, Fibestos and Plastacele. Molded by General Plastics Corp.

[1] "A trio of typical airmen," MODERN PLASTICS *21*, 102, 170 (March 1944).

A pressure-tight, blind grommet

ALTHOUGH the grommet finds its way into hundreds of civilian items and into almost every machine of war, the average citizen is unfamiliar with this device which prevents chafing and provides necessary insulation for electrical wires, control cables or hydraulic lines wherever they are passed through holes in bulkheads and partitions. Grommets are commonly made of rubber, porcelain, brass or steel, and their production in plastics is understood to bring about a radical change and improvement of construction.

Much skill went into the ingenious construction of the plastic blind grommet which is clearly pictured in Fig. 1. The two molded sections of this grommet are so designed that one part slips inside and meshes with the specially constructed wall section of the second half. No special skill or knowledge is needed for the assembly of the unit. Slipped onto a special application tool, the plastic grommet is thrust through the hole cut in the partition until a specially designed cut-back section on the inner surface of the grommet hooks the edge of the wall section on the far side. At this point the applicator tool wedges the second molded section into the first and locks it in place at the point at which the partition stops further progress. Thus the two molded parts become an integral unit.

On the "pressure-tight" model a flexible ring is slipped over the outside of the grommet after its installation. After the cable has been passed through the grommet, this ring is slipped onto the cable and forced inside the grommet. By wedging itself between grommet and cable the ring forms a perfect seal which prevents the passage of water.

The plastic blind grommet is understood to possess an unusual combination of characteristics which, in the past, were only found singly in a dozen different types. It is "blind" fastening: that is, it can be applied by one man from one side of a partition. This feature saves not only time but labor, and in many cases invites great simplification of construction and design. Further, the grommet is self-locking. A safety-catch prevents the assembly from coming loose and slipping out of position. The assembly has been shown to have excellent resistance to vibration and to give maximum protection against corrosion and electrolytic action. The uniformity of the molded parts and their low cost make the grommets a practical application for almost every field. At the same time, fast and economic installation is a long-hoped-for boon to the war production program.

During war time, the shipbuilding program provides one of the best proving grounds for evaluating the worth of a new development and estimating its place in postwar industry. Between every compartment throughout a modern ship there is a bulkhead. These bulkheads must be pierced by the multitude of electrical cables which comprise the nerve center of these steel leviathans that carry war materials to all corners of the world. At the same time, shipbuilding standards demand that in all underwater sections of the ship, one compartment must be definitely and permanently sealed from another. Many expensive and awkward applications have been made in an effort to accomplish this purpose. But with the development of the new water- and pressure-tight device for the plastic blind grommet, a method has been devised that allows application of the grommet from one side by one man to provide "pressure proof" sealing around cables and tubing. This arrangement also eliminates welding and packing. The design of these plastic grommets provides for great variance in plate thickness, which makes possible the use of the same size grommet in many applications.

Many controls and cables in aircraft manufacture also demand protection against fraying and chafing, and the

1—The two-piece plastic grommet is designed to be applied by one person from one side of a partition. The cut-away section in the foreground shows how the two halves become as one after being pressed into position by a special applicator. 2—At A the grommet is on the applicator ready for insertion. The two halves are then locked in position as in B. The cross-section of the locked grommet, C, shows the variation in wall thickness that can be accommodated. At (1) the flexible ring is pressed on the outside of the grommet. Next, (2), it is pushed onto the cable. At (3) the ring is forced inside the grommet and over the cable to form a water-tight pressure seal

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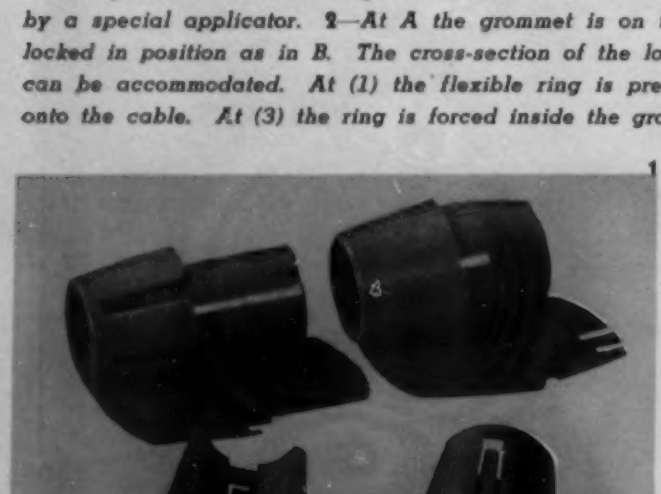
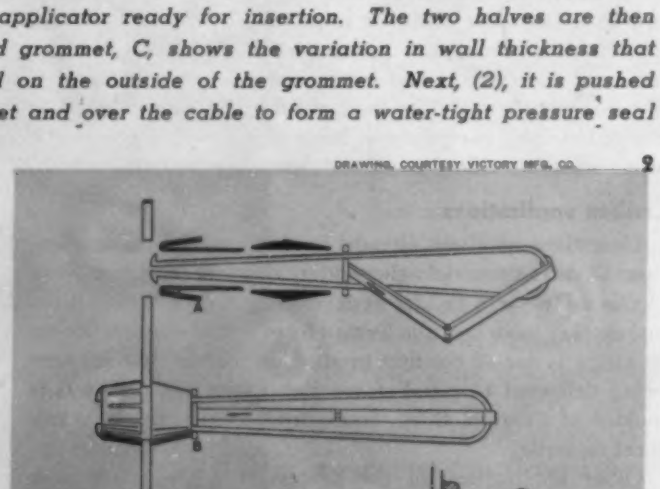
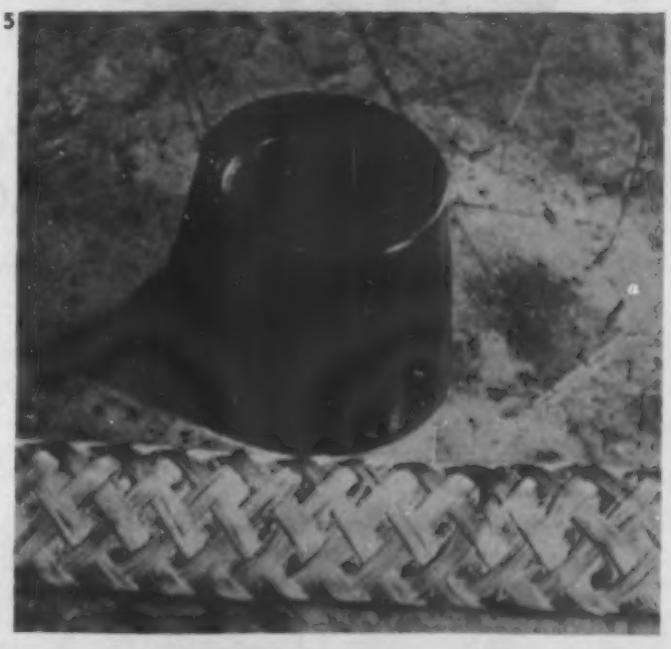


DRAWING, COURTESY VICTORY MFG. CO. 2



3 ALL PHOTOS, COURTESY VICTORY MFG. CO.



3—Tests showed that after a cable had been oscillated back and forth through an iron grommet for 17½ hr. the wires protecting the cable were very badly shredded. 4—When a lead grommet was used in the same test, the cable held up satisfactorily but the grommet was deeply cut. 5—After being vibrated for 17½ hr. both the plastic grommet and the cable were in good condition. 6—The 3 types of grommets were set up side by side in the test to evaluate their resistance to vibration

pressure seal feature is particularly valuable to stratosphere flying. In the manufacture of tanks, fixtures and fighting apparatus must be insulated from the balance of the machine. The seal of the plastic grommet is so engineered that its motility reduces to a minimum the strain on the grommet set up by the constant movement of the cables. In addition, the large bearing surface of this grommet distributes the rubbing and weight of the cable over an extended area, and the use of clear materials simplifies the task of inspection.

Recently tests were conducted by the Plastics Industries Technical Institute for the purpose of evaluating the performance of a grommet molded of saran against that of a lead and a steel grommet during vibration of an armored cable. Saran was selected as the molding material in this particular case because of its nonflammability. Work is also being done in molding the grommets from other types of plastics. In this test each of the three types of grommets was mounted in holes bored in a steel partition and strung with identical lengths of cable (Fig. 6). The parts were oscillated back and forth at a rate of approximately 100 times per minute for a total of 17½ hours. The last 7 hr. were conducted with a 200-g. weight hanging at the end of each of the cables. According to the Institute reports on the tests, the first break in the wires of the armored cable that passed through the iron grommet occurred in 4 to 5 hours. After 17½ hr. the cable was badly shredded (Fig. 3). The lead grommet was deeply cut by the edges of the hole bored in the steel plate. The cable, however, after 17½ hr. or 105,000 vibrations was in satisfactory condition although beginning to fray. Both the plastic grommet and the cable showed no appreciable wear at the end of the full testing cycle. *(Please turn to page 200)*

A study in home lighting fixtures

LOOKING toward the postwar years when many of the new ideas for improved home lighting will be put into actual practice, the Utilities Research Commission of Chicago has constructed in the testing laboratories of the Commonwealth Edison Company a full-sized room, such as is found in the average home, for the purpose of testing and modifying lighting schemes which appear to have unusual possibilities.

A recent report on laboratory findings and results achieved with some of these ideas reveals several interesting applications of sheet thermoplastic materials in fluorescent ceiling lamps and suggestions for other plastic applications in portable floor lamps having either circular fluorescent tubes or a combination of these tubes and an incandescent lamp.

In home lighting, the object of the tests was to achieve beauty, comfort and convenience as well as maximum lighting efficiency. Taken into consideration was the belief that in living rooms, sun porches, bedrooms, recreation rooms, etc., old types of overhead lighting are no longer popular and that in thousands of residences these ceiling fixtures have been removed and the outlets capped over.

PHOTOS AND DRAWINGS NO. 1, 2, 3, 4 AND 5, COURTESY COMMONWEALTH EDISON CO.

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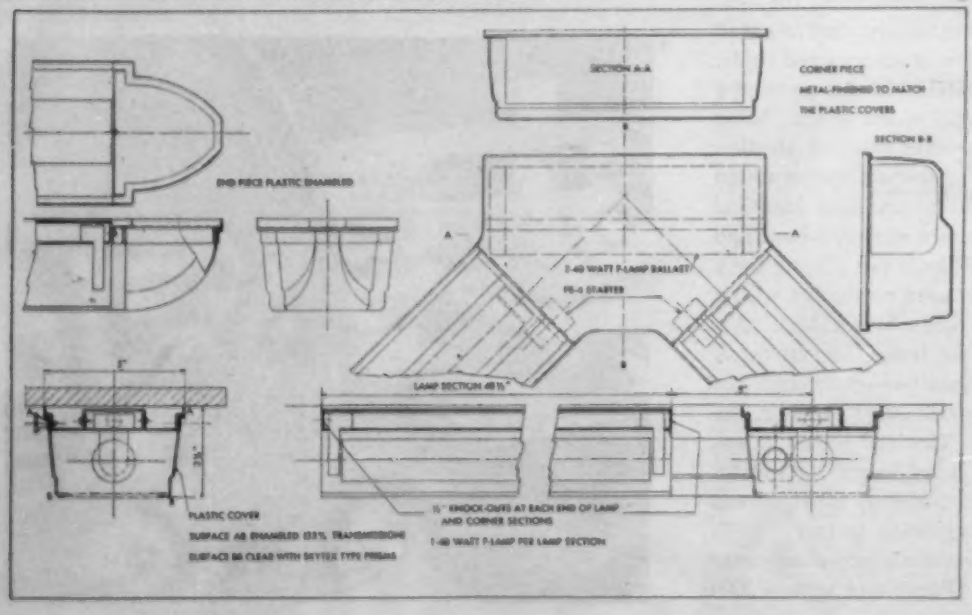
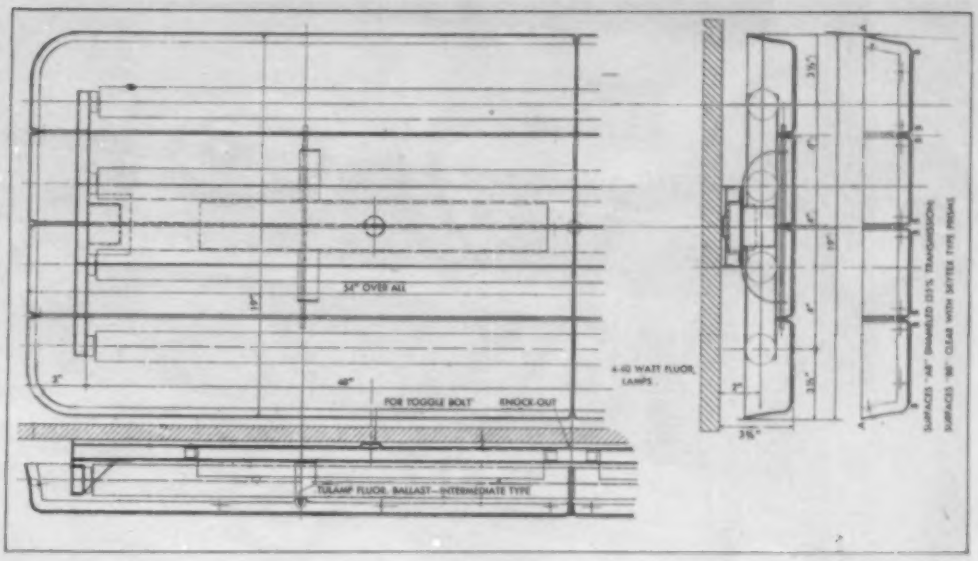


1—When fluorescent ceiling fixtures are designed in an L-shape, they can be positioned over furniture groupings where they give sufficient light for the work in hand without leaving the rest of the room in darkness. **2**—*In sharp contrast, the typical portable lamp in use today has a limited light radius.* **3**—*This working drawing relates to the L-shaped lamps*

4—Design details of the 4-light luminaire for the dining room are clearly indicated in this scale drawing. 5—Where general illumination is desirable, as in a dining room, a center fixture is recommended. 6—Only 3 different molds are required for the plastic enclosure on the center luminaire. Besides these two side covers there is an inside shield



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A proposed living room arrangement in the test room employs L-shaped surface-mounted fluorescent ceiling units so treated that they give enough light for reading, writing and the playing of games at all usual furniture positions (Fig. 1). The lamps are positioned about 30 in. from the walls or directly over the furniture groupings. While the fixtures can be partially recessed if installed at the time the home is built, it is believed that complete recessing would prove to be disadvantageous—creating a dark, cheerless ceiling.

The covers or shades of these ceiling lamps are molded of cellulose acetate sheet. The thickness of the plastic in the sample fixtures is about sixteen thousandths of an inch, but it is believed that a thicker material probably will be necessary. Enamel is sprayed on the sides of these fluorescent lamp shades to reduce brightness to about 0.7 candlepower per square inch, or in line with Utilities Research Commission commercial standards. The bottoms, however, are practically clear and have Skytex-type prisms or ribs to give proper light control.

The illumination at furniture positions directly underneath these fixtures averages 16 foot-candles, and the immediate aim is 20 foot-candles. Tests show that this light enhances and visually enlarges the appearance of the room, giving the walls, drapes and furnishings better color response and more cheer than with usual arrangements in which only portable lamps are used (Fig. 2).

With respect to portable lamps, which are still needed for localized illumination and also for appearance, the Commission stated its belief that a demand for fluorescent portables may be expected when material restrictions are removed. "Lamp manufacturers have announced 20-, 30- and 40-watt fluorescent lamps each (*Please turn to page 204*)

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6 PHOTO NO. 6, COURTESY GENERAL PLASTICS CORP.

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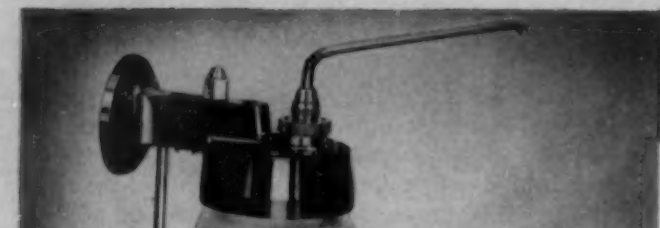

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PLASTICS

HEALTH AUTHORITIES ARE AGREED THAT FRESH air is essential to restful sleep. But on cold winter nights when the temperature has dropped sharply and the heat died down, the windows that were so rashly opened wide in the warmth of early evening seem a long, long way from the comfort of a warm bed. Memories of icy floors and chilly blasts should insure the popularity of these thermostatically controlled automatic window ventilators (Fig. 1) once they are in full production.

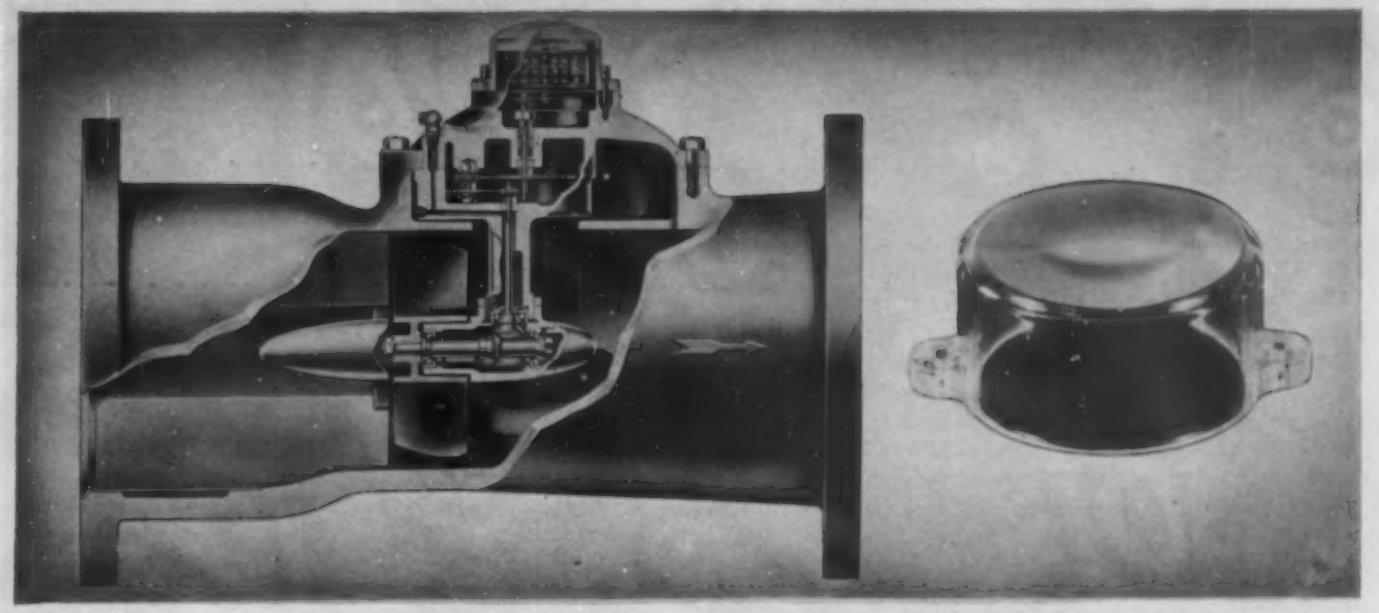
When the vane, which is positioned between the window and the back panel, is fully closed, it is tilted against the partially raised window. When fully opened the vane remains in an upright position. Although the frame of these ventilators, known commercially as Air Sentries, is made of aluminum, most of the remaining parts are of plastics. Insulation for the thermostat consists of sheet cork covered with a paper-base phenolic laminate, and a shaft connecting the thermostat to the air inlet vane is of linen-base laminated phenolic gear stock, which has the advantage of low thermal conductivity. The methyl methacrylate of which the air inlet vane and the back panel are formed effects a considerable saving in shipping weight besides being weather resistant and highly stable.

Credits—Materials: Bakelite, Lucite. Designed by E. O. Gillen for Automatic Window Ventilator Co.

WHEN A PATIENT STEPS INTO A HOSPITAL FILLED with dread of the ordeal that lies before him, he is heartened by the air of efficiency and gleaming cleanliness that pervades its walls. Such effects are no accident. They are the result of careful attention to every detail of hospital equipment. These septisol soap dispensers (Fig. 2), for example, were formerly made of copper and brass which, being affected by verdigris, had to be frequently and carefully polished. By utilizing a phenolic material for the head and base, a permanently bright fixture requiring almost no maintenance was achieved.

Because of the relatively complex shape of the molded part (Fig. 2), the split-cavity transfer mold contains an unusual number of removable sections. The head which supports the soap container has an inside thread formed by a large removable core plug. Within the head, there are a round opening and a smaller threaded hole, both of which are formed by pins fitting into the larger plug. In addition, the base section includes a core which runs for almost its entire length and is threaded at the end. There are also two threaded holes on the lower side of the base and one at the top.

Credits—Material: Bakelite. Molded by Chicago Molded Products Corp. for Vestal Chemical Laboratories, Inc.



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PRODUCTS*

ACCURATE FIGURES ON CONSUMPTION OR PRODUCTION are essential to every business. For example, pipe line companies are acutely concerned with the amount of oil pumped through their lines. Power plants need to know their hourly consumption of oil or water. To meet needs such as these, a new propeller-type flow meter for main line metering has been developed. The unit is equipped with a direct-reading six-digit counter and the body is of Venturi design which creates a more uniform velocity distribution where the flow meets the propeller.

Shielding the totalizer and serving as a magnifier to make reading of the meter easy are shatterproof bonnets of transparent methyl methacrylate (Fig. 3). Each bonnet, weighing 83 grams, is molded in a single-cavity mold on a 50-second heat cycle. Since it is a rather deep cup shape of a clear material, and since the top of the bonnet acts as a magnifying glass, the problem in molding this part was to do so in such a way that no gas pocket could form in the magnifying top. This had to be accomplished without recourse to vent pins in that part of the mold. It was possible to design the gate in such a way that the material flowed over the top of the bonnet before the material flowing around the side walls met, thus avoiding the trapping of gas.

Credits—Material: Lucite. Manufactured by Firestone Rubber and Latex Products Co. for Builders Iron Foundry

4

NOT THE LEAST ANNOYING PART OF WOOL GARments is their tendency to shrink after washing. Despite guarantees to the contrary, the cleaned garment often bears little resemblance to its original appearance after it emerges from the cleaners. As a protection against such an occurrence, a new shrinkage control method for wool, which retains the original appearance of the fabric and supplies long-needed protection against repeated laundering and dry-cleaning, is now available through the use of a melamine resin.

This process stabilizes wool and wool blends without affecting the absorbency normally characteristic of wool, as opposed to the usual chemical methods for controlling shrinkage which actually alter the wool and destroy some of its valuable properties. Since it is an additive, it takes away none of these desirable qualities while reducing felting and preventing pilling and fuzzing. Wool treated with this resin has a higher resistance to alkali than untreated wool (Fig. 4).

The fabric is simply passed through an aqueous bath containing the resin and squeezed uniformly through a mangle, dried and heat cured. The material is then given a light wash to remove surface resins. Such application is permanent for the life of the garment.

Credits—Material: Lanaset

* Registered U. S. Patent office.

Tuning in on the air waves

DURING this war, our Armed Forces have come to depend to an ever-increasing degree upon the products of the laboratory for the means of both offense and defense. A large number of these instruments belong to the field of electronics—the most widely publicized, yet at the moment the least known, being an electrical device which, authorities agree, probably had more to do with England's winning the Battle of Britain than any other one piece of equipment. This particular instrument and a great many other necessary units which are in common use on all battlefronts, would be useless were it not for the common radio tube.

While tubes for electronic equipment are built in many sizes ranging from a tube no bigger than a peanut to a bottle-like tube of undreamed of proportions, they stem essentially from the same root—a radio tube. If you have tried lately to purchase tubes for your radio, you have probably discovered the sad truth—they are practically unobtainable. Yet, the tube-making industry is turning out many times the number of units it did in peacetime. Geared directly to this tube production is the production of phenolic radio-tube bases (Fig. 1) which, in a variety of styles, are used on nearly every type of tube in existence.

When requirements for bases sky-rocketed with the sharp increase in demand for tubes, one Connecticut molding company was ready for the increase having developed, some time before, a completely automatic system for molding the bases in production quantities. These machines were designed to be completely universal. By virtue of this arrangement, different molds can be quickly assembled into the machine so that many different types and sizes of radio-tube bases can be produced at will. The unit consisted essentially of a one-ram upward-acting hydraulic press about which are assembled the various loading fixtures, pill hoppers, automatic traveling mechanisms and knock-out equipment. The machine was designed so that one complete production mold—force plugs and cavities—would be curing while the second complete mold was out of the press with the molded bases being knocked off the force plugs and the cavities being loaded with preforms preparatory to the next shot.

The success of the automatic loading fixture depends on the use of ball-pill preforms. To make this possible a special punch and die set was manufactured for an automatic rotary preformer. Figure 2 shows a close-up of this preformer with the ball pills being brushed from the rotating pilling table and dropping into a storage box. The material delivery funnel, which deposits the material on the rotating table at the loading station, is visible in the upper left-hand corner of this picture. As the table continues to rotate, it carries the material with it until a series of scrapers are encountered. These scrapers serve not only to hold back the excess material but to meter the amount of material which is permitted to remain in the pilling cavities.

The need for round or ball pills is evident in Fig. 3, which shows the two preform hoppers—the one, funnel type, for intermediate storage; the second, rectangular in shape and equipped with a vibrator. A loading fixture, containing, in this case, 28 holes for a 28-cavity mold, is held in position directly below the vibrating hopper. Holes are located in the vibrating hopper to correspond to those in the loading fixture. The vibration of the hopper causes one preform to drop through each of its holes into the loading fixture below. The loading fixture is placed close beneath the hopper so that when each pill has dropped into position in the fixture, it effectively blocks up the holes in the hopper, preventing additional pills from coming through. Next a thin plate is slid between the hopper and the loading fixture, closing all the holes in the hopper so that the loading fixture is free to travel to the loading position which is directly over the cavities.

At this point the bottom plate of the loading fixture moves to the unloading position and the preforms are dropped into

1—Production of phenolic radio tube bases in a variety of styles and sizes has been facilitated by the development of a completely automatic system of molding. 2—An automatic rotary preformer equipped with a special punch and die set shapes the ball-pill preforms upon which the success of the automatic loading fixture depends

ALL PHOTOS, COURTESY BRIDGEPORT MOULDED PRODUCTS, INC.

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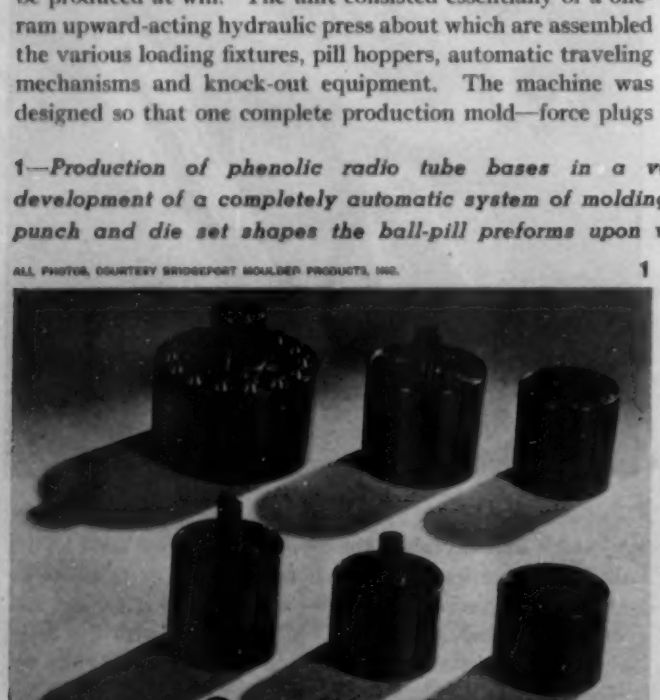

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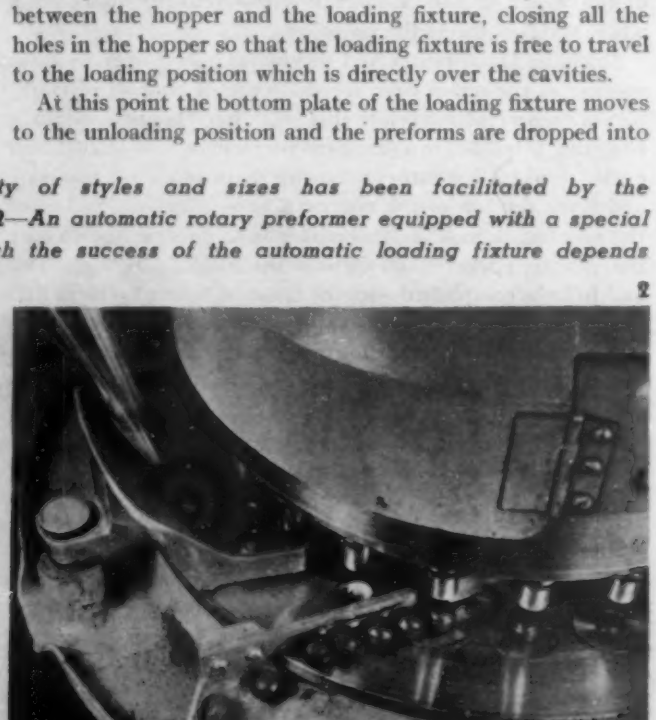

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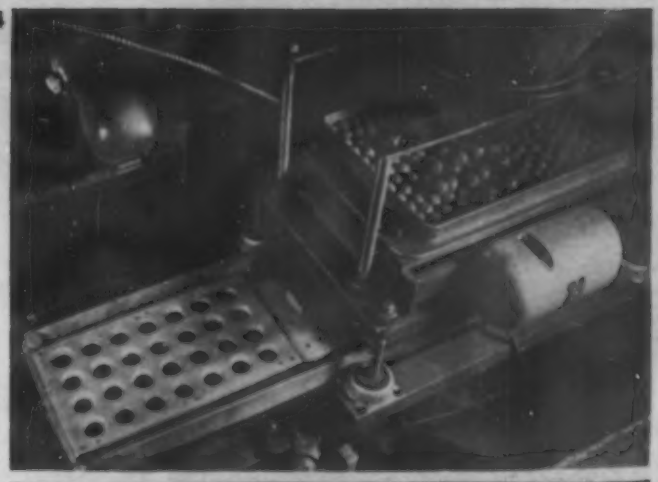

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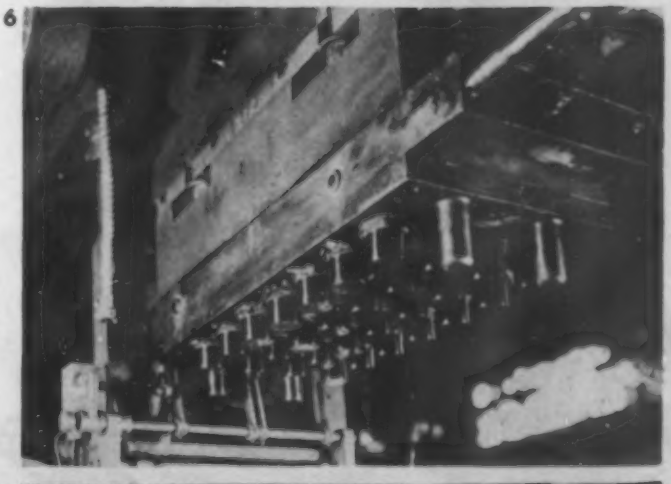

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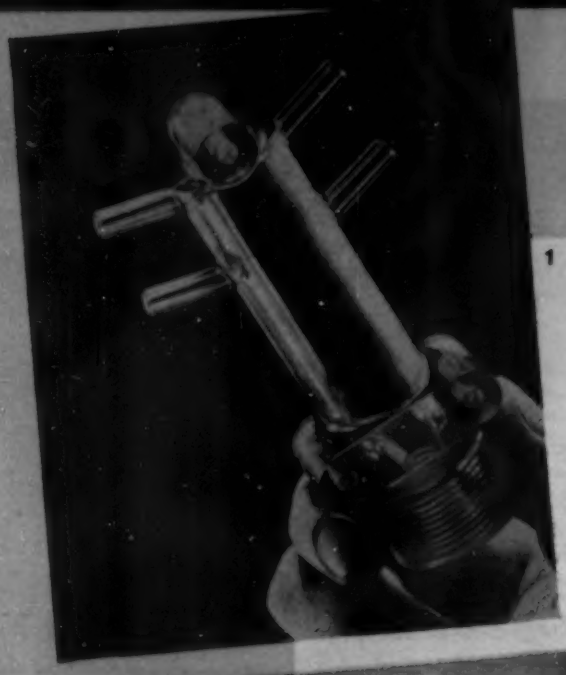
7

3—The loading fixture is held immediately below the vibrating hopper so that the preforms can drop directly into their proper holes in the fixture. 4—When fully loaded, the fixture moves to the unloading position where the preforms are dropped into the cavities which are positioned immediately below. 5—With the preforms loaded in the cavities, the press is about to open and allow one set of cavities and force plugs to move out while the other set moves in. 6—When the press is opened, the molded tube bases remain on the force plugs. 7—Three knock-out pins are used to remove each tube base

the cavities. The loading fixture can be seen at the lower left in Fig. 4 just after the pills have been transferred to the cavities of the mold. While this cavity is being loaded, the second complete mold is in the closed or molding position as can be seen in the left background of Fig. 4. After the curing time has been completed, this second mold will open downward—the tube bases remaining on the force plugs. A chain mechanism then pulls this set of force plugs from underneath the press and, at the same time, pulls the set of force plugs for the second mold into a molding position. The next step is for the cavities to be pulled out sideways by the same type of chain mechanism while the second set of cavities with the preforms already loaded is pulled into molding position in the press. The press then automatically closes on low pressure; breathes, if necessary; and then closes completely for the cure. Figure 5 shows the ball preforms loaded in position in one of the 28-cavity molds. The second mold in the background is still closed. However, since the time cycle is almost complete, this mold is ready to open and move out of the way, permitting the second mold to take its place.

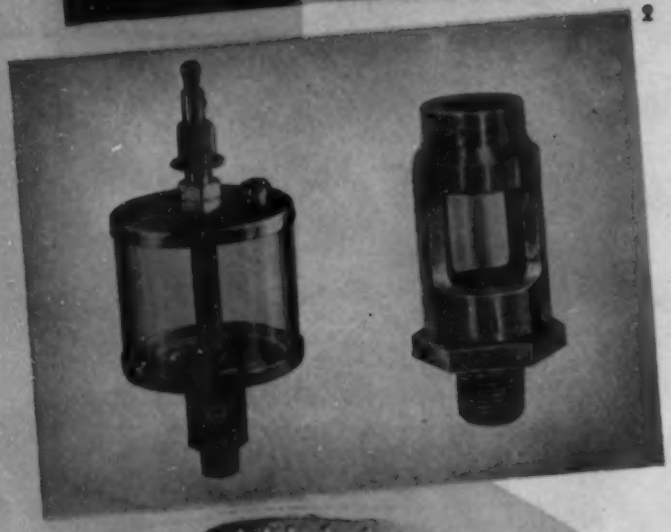
As mentioned previously, the molded tube bases remain in position on the force plugs (Fig. 6) after the press is opened. Figure 6 shows clearly the flash around the parting line and the holes in the bottom of the bases which have been molded through. Three knock-out pins are used with each force plug to remove the molded bases. These pins can be seen in the lowered or ejecting position in (*Please turn to page 204*)

PLASTICS



1

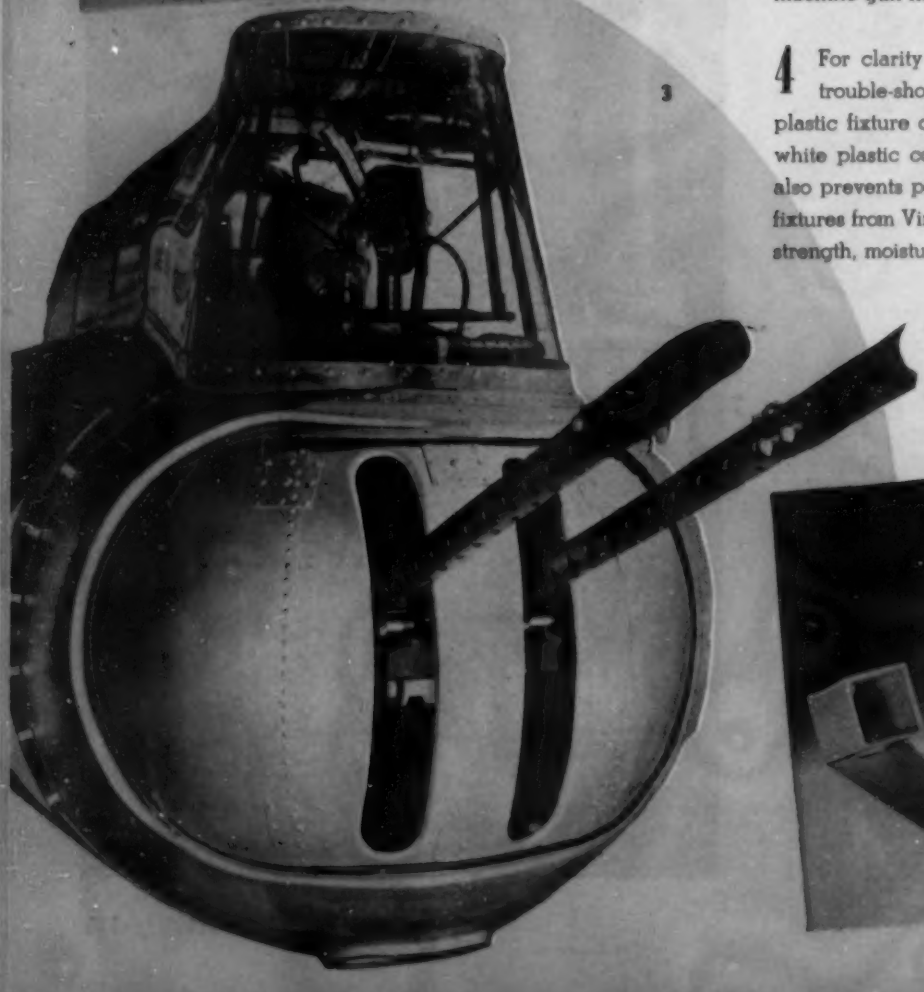
1 If water should get into the 100-octane gasoline used in combat planes, it can cause as much trouble as a well-aimed Jap bullet. This alternate static vent drain, molded of Tenite II by Modern Plastics Co., is used by Douglas Aircraft Co. in the fuel system of its aircraft. Water present in the gasoline is automatically drained to this vent where it accumulates and, regardless of altitude, never freezes



2

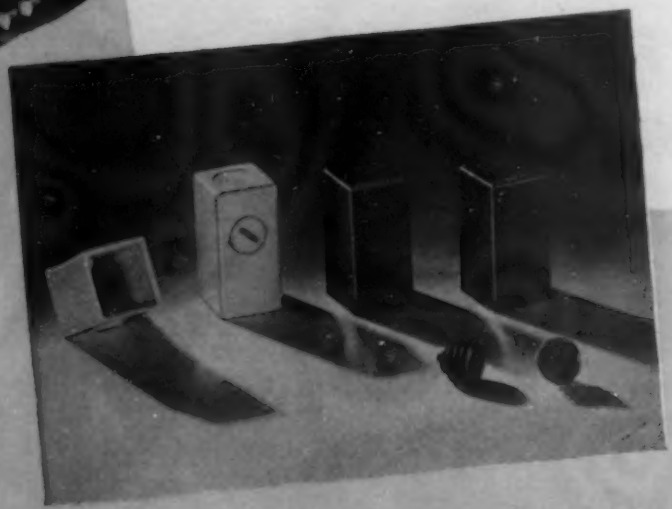
2 Constant worry regarding oil supply is eliminated through the use of Lucite reservoirs and sighting apertures. This material, used so successfully on aircraft enclosures, provides a quick and safe check of equipment in oil flow lines, reservoirs on automatic oilers and built-in, protective tubes on rotameters. The reservoirs, fabricated from tubes of the methyl methacrylate, are being used by Oil-Right Corp.; while the sights, bored from 1-in. diameter rods and currently in use with water-distilling units installed on Navy landing barges, are being manufactured for Wm. W. Nugent Co.

3 The tail gunner on a B-17 Lockheed Aircraft Corp. airplane operates from a smooth-functioning turret which gives the twin .50 caliber machine guns a 90° swing of fire throughout the entire cone as compared with 60° swing on the old type turret. The full Plexiglas sides and top give the gunner a better and quicker view of attacking fighters, its reflector sight gives him a better shot and its armor plate—an all-around "flak curtain"— provides needed protection against spraying ack-ack and machine gun fire



3

4 For clarity of procedure in wiring, replacement work and trouble-shooting, H. B. Sherman Mfg. Co. has adopted red plastic fixture connectors for use on current-carrying wires and white plastic connectors for grounding wires. This color code also prevents possible accidents. Detroit Macoid Co. molds the fixtures from Vinylite because of its non-flammability, high tensile strength, moisture resistance and electrical resistivity



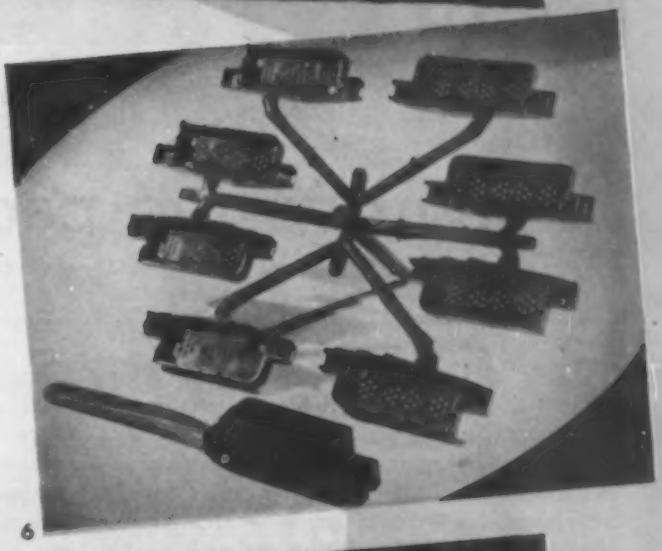
4

IN REVIEW

5 Children at the self-feeding age are well protected from crumbs and spattering by brightly decorated, transparent Lumarith bibs, designed and produced by the Alesite Corp. Non-toxic, non-flammable and stainless, the bibs do not support odors of any kind and can be cleaned simply by wiping the surface with a damp cloth

5

6 A damp toothbrush, packed in a travelling case, can cause many unsightly stains on clothing—a calamity which can be avoided by the use of the Ventomat. Injection molded of Lumarith X by Gemloid Corp. for 20th Century Products in a variety of colors to facilitate identification, these handy little toothbrush covers are produced 4 at a time in 8-cavity molds. Designed to permit air to circulate through the case, adding life to the bristles, the Ventomat emerges from the die entirely finished except for a minimum amount of assembly



6

7 Construction men, working in the holds of ships, are assured of clean, fresh air through the use of the portable "Ventube" flexible ventilating duct developed by E. I. du Pont de Nemours and Co., Inc. Designed for either blower or exhaust systems, the unit consists of a tempered steel helical spring inside a tube of specially selected fabric which has been impregnated and coated with a high-grade abrasion-resistant compound that is water-resistant and impermeable to air. When bent to an angle of 180°, it will exhaust more air than the old style tubing and, in addition, it weighs only half as much as an equivalent length and diameter of the earlier type non-collapsible Ventube

7

8 Spotlights on jeeps and army trucks are being outfitted with handles of Tenite. Like the equipment of which they form a part, these 2-piece handles have great mechanical strength and toughness, and their wear resistance is proverbial. Both the top and the shank, which has a molded-in insert, are molded in 2-cavity dies by the Cruver Mfg. Co. More than a million of these handles have been manufactured in the past four years

8

PHOTOS, CORCORAN-BROWN LAMP DIV., ELECTRIC AUTO-LITE CO.

1

2

1—Suspended from racks, spark plugs move along a conveyor to the dipping tank which is here being refilled. Coated plugs emerge at the right and are routed back over the tank to the first station for unloading. **2**—*Plugs as they appear before and after being dipped in the coating solution*

Assembly line packaging

by WALTER H. PRINE*

EXTENSIVE work has been carried out during the course of this war to protect finished military goods against the severe handling and corrosive elements usually encountered in the interim between final processing and actual use in the field. In the past, parts for export have been wrapped with successive layers of impregnated papers and cloth and given a final wax dip. Where the equipment did not lend itself to this treatment it was covered with a film of grease and packed in water-tight boxes.

This protective packaging work has been greatly expedited by a recent development whereby military goods are dipped into a heated bath of ethyl cellulose coating solution.

Our organization first considered the use of ethyl cellulose for packaging when a production line was installed for the manufacture of spark plugs. At that time the wrap method was employed with first one end of the plug and then the other being dipped. In a final operation, an identifying label was affixed to the package and the plug placed in a paper carton with instructions on how to remove the coating.

The idea was conceived to seal the plug in its protective coating with a single dip—a paper strip supporting the plug as it passed through the cellulose dip tank. Placing the paper tag on the plug at the same time the terminal was added to the assembly ruled out an extra operation. In fact it was possible, with the use of paper strips, to eliminate one handling since the identification of the sealed plug and instructions on the removal of the coating could be printed on the tab. However, at present, non-wicking string is used to support the plugs in the bath pending Government approval for the use of paper tape.

* Corcoran-Brown Lamp Div., Electric Auto-Lite Co.

Preliminary laboratory work, carried on in conjunction with a manufacturer of the ethyl cellulose, showed this process to be adaptable to a conveyor system. It was determined that the thickness of the coating could be controlled by the following factors:

1. Temperature of the plug before dipping.
2. Length of immersion time.
3. Temperature of the ethyl cellulose bath.
4. Method of withdrawal from the dip.

Tests wherein the temperature of the plug was varied from 80 to 165° F. showed that the thickness of the coating can be reduced approximately 15 percent by this temperature change. It was also determined that if the object is heated too high before immersion there will be no chilling effect and, consequently, no exudation of oil to prevent sticking. Under such circumstances the coating will not peel off freely as it should.

The length of immersion time proved to be the most critical factor. Immersion for a period ranging from 1 to 10 sec. resulted in coatings with a thickness of 0.055 to 0.090 in. when the plugs were dipped in a bath held at 375° F. Varying the temperature of the strip coat bath from 340 to 375° F. had the effect of decreasing the thickness of the coating by approximately 20 percent.

Investigation of the method of introduction and withdrawal of the plug from the strip coat indicated that the plug could be introduced in any manner—the best being that which trapped the least amount of air. The most uniform coating was obtained by withdrawing the plug slowly after complete immersion—made at any (*Please turn to page 202*)

Annual Fall Conference

SOCIETY OF THE PLASTICS INDUSTRY

"PLASTICS — tomorrow's word" was the keynote of the 2-day annual Fall Conference of the Society of the Plastics Industry which was held on Monday and Tuesday, Nov. 13 and 14, at the Waldorf Astoria Hotel, New York, N. Y. The meeting featured a representative exhibit of current plastics applications — indications of what plastics will and can do in the years after the war. Papers delivered during the two morning and afternoon sessions included discussions on many new materials and processing methods as well as forums on the role of plastics in architecture and the merchandising of these materials.

The Monday morning activities were divided between the general session and the technical session presided over by W. H. Milton, Jr., General Electric Co., and C. W. Blount, Bakelite Corp. George K. Scribner, president of S. P. I., was toastmaster at the first day's luncheon at which the Honorable Newbold Morris, president, New York City Council, welcomed the members of the S. P. I. to New York City with the suggestion that some of those present might find it the place to work as well as play. The afternoon was devoted to a number of group meetings. N. O. Broderson presided over the Button Group, James B. Neal over the Compression Group, Elmer Szantay over the Extrusion Group, Roy F. Layton over the Fabricating Group, Daniel D. Whyte over the Injection Group and F. G. Schranz over the Machinery Group. Later in the afternoon the members of the S. P. I. had the opportunity of seeing the films "The Formica Story" by Formica Co. and "Careers for Cellulose" by Hercules Powder Co. At the dinner which followed, Ronald Kinnear, chairman of the Board of the S.P.I., acted as toastmaster and introduced the Ben Yost Choir as well as the featured speaker, Col. Williard Chevalier.

Tuesday morning was devoted to the S. P. I. Business Session at which M. M. Makeever, vice-president of S. P. I., was the presiding officer. The president's message was delivered by George K. Scribner. Five reports followed: "The S.P.I. Engineering classification of plastics" by N. J. Rakas of the Technical Committee; "S.P.I. at work" by Wm. T. Cruse, executive vice-president of S.P.I.; "Report of the Canadian section" by K. H. Braithwaite, Duplate Canada Ltd.; "Report of Pacific Coast section" by Roy L. Peat, Plastic and Die Cast Products Corp.; and "Report of Midwest section" by Elmer E. Mills, Elmer E. Mills Corp.

James B. Neal, Norton Laboratories, Inc., acted as toastmaster at the luncheon which was addressed by Lew Hahn. James R. Turnbull, Monsanto Chemical Co., presided over the afternoon session. Again movies were shown in the late afternoon —"Shape of Things to Come" by Boonton Molding Co. and "Proving Ground" by Celanese Celluloid Corp. An organizational meeting of the low-pressure molding group was also held following the main afternoon event, the Merchandising Forum on plastics. The final banquet at which George K. Scribner acted as toastmaster, was first entertained by Harry Hirshfield and then brought to a serious consideration of present events by Rear Admiral William H. Standley, who spoke on "How We Can Work With Russia."

In large part, credit for the success of the convention should go to the Conference Committee which was responsible for the very interesting and instructive program that filled the two days. C. S. Shoemaker, Dow Chemical Co., acted as chairman of this committee which was composed of Charles A. Breskin, Modern Plastics Magazine, Chris J. Groos, Boonton Molding Co., Truman Handy, Celanese Celluloid Corp., J. D. Herlands, Button Corp. of America, C. S. Lawrence, American Plastics Corp., Herman B. Lermer, Celluplastic Corp., E. W. Levien, Mastercraft Plastics Co., Inc., Sidney Lewis, Advance Molding Corp., Alfred C. Manovill, Plastic Manufacturers, Inc., C. W. Marsellus, Universal Plastics Corp., Bernard Shiller, Ardee Plastics Co., William Scott, Allied Plastics Co., R. D. Werner, R. D. Werner Co., Inc., and Louis C. Wolfson, Ideal Plastic Corp. The following reports are digests of the original speeches.

Plastics and architecture

On Sunday afternoon, Nov. 12, representatives from the architectural and plastics fields met for an afternoon's discussion on the role of plastics in architecture and architecture in plastics. George K. Scribner presented Arthur Holden, president of New York Chapter of American Institute of Architects, and presided over the first half of the meeting which was devoted to the following 4 speeches: "This is the Building Field," by Kenneth Stowell, editor of Architectural Record; "This is the Plastics Industry," by Charles A. Breskin, editor and publisher of Modern Plastics; "What the Architect wants to know about Plastics," by Howard Vermilya, American Institute of Architects and technical director of John B. Pierce Foundation; and "What the Plastics Industry would like to know about Architecture," by Clinton W. Blount, Bakelite Corp. A brief resume of these four speeches is presented on this and the following page.

KENNETH STOWELL — The building industry deals with space — it encloses that space and it conditions that space. It arranges space so it can be useful, so that the members of the plastics industry can make more things to put into that space. And it is also on the lookout for new equipment to

make the space it encloses pleasanter and more convenient. It does not make one streamlined product, but thousands of different types and sizes of products for different uses. To fill the requirements of all these phases of building, the industry looks to plastics for assistance in the postwar home.

CHARLES A. BRESKIN — To meet some of the postwar building needs, plastics offer an infinite variety of materials, prepared to individual tastes and specifications. A British study of plastics in building listed over 190 actual and potential uses of these materials, including suggestions for heating, ventilating and plumbing, for electrical equipment, for lighting, for gas and mechanical installations and for acoustics and communications.

Perhaps the plastics with the most far reaching implication for postwar building are superstrong, lightweight materials produced from the marriage of new synthetic resins with cloth — duck, canvas or glass fiber — and paper. These have been employed widely in low-pressure laminating, whose chief virtue lies in the fact that it makes possible the creation of structures of great size and complex shapes with a high-strength, light-weight ratio for a comparatively low investment in molds and tools.

HOWARD VERMILYA — Fundamentally the architect wants to know how he can use plastics with adequate assurance of performance. Most of the data now available on the properties and limitations of these materials are in the language of the physicist and the chemist, relatively unintelligible to the architect. Further, the architect is not interested in properties except as they relate to performance. His interest is in procuring information which will assure him that in any particular application, he is using a plastic that is appropriate and that will turn in a good performance.

CLINTON W. BLOUNT — The principal difficulty seems to be that the members of the plastics industry know so little about building that they are not in a position to know what they do not know. The need is for simple tests that will indicate whether or not a particular plastic is suitable for use in, for example, kitchen wall coverings or stair treads. Using kitchen wall coverings to illustrate the uncertainty of the plastics industry as to the needs of architecture, the question of the need for heat-resistance in such coverings usually brings the answer that excellent resistance is essential. Yet paints used behind the stoves in kitchens and behind radiators are not, strictly speaking, heat resistant.

Following Mr. Blount's speech, the meeting was thrown open to a general question and answer session. Two panels of experts were on hand. Mr. Sanders, industrial designer and member of the Architects Group, acted as moderator for the architects and Clinton Blount represented the group from the plastics industry. The architects panel included A. Gordon Lorimer, Chief of the Bureau of Architecture, Department of Public Works, New York City; D. Leopold Arnaud, School of Architecture, Columbia University; Simon Breines, architect, A. I. A.; Dean Axline, A. I. A.; Harold Sleeper, A. I. A. and author of several important technical publications; Don Graf, architect and a well-known writer on the subject of architecture; and J. Gordon Carr, architect and designer. Representatives of the plastics industry were Ted Swedlow, Swedlow Aeroplastics Corp.; H. W. Collins, Owens-Corning Fiberglas Corp.; W. W. Jackson, Celanese Celluloid Corp., C. A. Norris, Bakelite Corp.; J. D. Lincoln, Virginia-Lincoln Corp.; George Clark, Formica Insulation Co.; H. J. West, American Cyanamid Co.; Jack Peglar, Haskelite Manufacturing Corp.; T. W. Sharp and Howard Smith, Bakelite Corp.; and W. C. Goggin, Dow Chemical Co.

In answer to the first question, "What can be said of the advantages of plastics in the building field in comparison with traditional materials," Mr. West said that it is impossible to compare plastics as one class with other types of materials. This is an important point since in replacing other materials with plastics each characteristic of the plastic must be considered in the light of the performance required. There is likely to be a tendency to expand synthetic resins with cheaper materials and that is one thing that architects will have to be very wary of in the postwar era.

The question of the possibility of a large market in plastics walls precipitated a discussion of types of walls, feasibility of dry or wet wall constructions and the like. The statement was made that the advantages of synthetic resins for outdoor finishes are nowhere near as pronounced as they are for interior applications. The opinion was expressed that prefabricated construction is essentially a trend toward dry wall construction — away from constructions involving plaster, concrete and, in a sense, paints. The tendency seems to be to organize building in such a way that the entire frame goes up in units.

Plastic moldings and trim produced by extrusion was mentioned as having a definite postwar function especially with contemplated improvements in the materials. One of the panel expressed the belief that plastic materials will contribute much to such items as window frames and window trims. They may solve the problem brought forth by metal frame construction where sweating is extremely serious since there is relatively low transfer of heat through thermoplastic materials. This was followed by a discussion of the possibility of laminated plastics for stair-risers, emphasis being given to its ease of maintenance.

The future of plastics pipe and tubing was taken up next. The thermoplastic pipe now on the market is up to standard. It can be assembled more rapidly than metal pipe, and when properly installed has been eminently successful. Among other things, it will stand freezing but cannot withstand high steam pressures or boiling water. At the present time, however, its cost puts it beyond the range of domestic work but it is very practical, economically, for industrial plants. Thermosetting pipe is subject to the same limitation in temperature as thermoplastic. The chemical resistance however, is not in the same category.

A question of the possibilities of large molds — for the forming of an entire room, for example — precipitated a discussion on practical mold sizes, with the molders informing the architects that there is no limit to the size of mold or the size of parts that can be made by low or no pressure molding. Much work has already been done with clear plastics, although from the standpoint of economics the cost would be about ten to one. Again, there are certain limitations to the material which would have to be considered.

In the general discussion that followed this planned series of questions such things as the architects' reluctance to try new applications in plastics and the possibility of a clearing committee being formed to enumerate a series of tests to determine the relative suitability of various materials for use, were brought up. The question of cost and how to reduce it brought on a discussion of materials and their applications. It

was agreed that the important question here was not the initial cost but that of the end use. Again, the question of a definite series of standards arose. It was generally conceded that this is one of the basic needs for effecting cooperation between plastics and other industries. Attention was again directed to the feasibility of large molds and the possibility of utilizing plastics for surfacing large wall structures in a single unit. This question closed the discussion period.

Contract termination and adjustment

Col. E. W. Rawlings, Chief, Readjustment Div., Army Air Corps.

To a large extent, the future of the plastics industry will depend on how successfully the work of reconversion is carried out. The problem is really twofold. Preparations must be made for the big job of terminating contracts and disposing of property. But, at the same time, work must continue on items currently in production. As a matter of fact, the job of properly terminating the various contracts can help our present production. Reduction in the amount of paper work involved in contract termination leaves management with more time and energy to devote to current war production.

The Contract Settlement Act of 1944 is probably one of the soundest pieces of legislation now on the books. Of particular importance is the provision for direct dealing with sub-contractors in case of serious difficulties. However, if governmental agencies were always to deal with sub-contractors the job would never be done and Government would come to play an ever greater role in business. Consequently, it is essential that business start doing its own work. Internal organizations should be developed and properly manned to handle all readjustment problems.

Until the recently issued joint Army-Navy terminations regulations, each of the services had its own interpretation of the basic law. Such an arrangement can be very confusing as when, for example, the fourth tier sub-contractor does not know with whom he is dealing and everyone with whom he is dealing is trying to do the job in a different manner. To remedy this situation representatives of both the Army and the Navy met and eliminated differences in their basic regulations, and came out with a joint regulation that is applicable to all contractors with whom they deal. The joint regulation also adopted a non-technical approach to the job of termination with the result that members of the military services now can sit down and negotiate with the contractor without need of detailed audits.

With a two-sided affair such as this, industry must recognize that it will lose out by coming up with details that are based on some lawyer's scheme for getting around something or for getting a little extra money. Such an attitude will cause the contracting officers of the Services to become technical — and then the desired answers to the questions of industry will be long delayed.

In preparation for the job of contract termination, the Air Forces is training personnel and decentralizing the work so that negotiations will not be held up by ignorance on the part of the Government representatives or because all decisions must clear through a single office. The Air Forces has also inaugurated a program designed to aid in the training of contractors — both prime and sub-contractors — so that they will understand the problems involved. It might be well if industry did something along these same lines — train their personnel, divide the work and assist in the instruction of their sub-contractors.

Tax relief and refunds

Maurice Austin, American Institute of Accountants, Klein Hinds & Finke, C.P.A.'s

There are various types of relief from the present high 95 percent excess profits tax rates afforded in the law, but the particular phase which has achieved a great deal of publicity and notoriety relates to the so-called Section 722 relief, the general relief from excess profits tax in cases of abnormalities.

The present excess profits tax is a means of taxing at special, high, almost confiscatory rates the profits realized in excess of normal rates as a result of conditions during wartime — not necessarily as a result of wartime production or war production for the services, but all excess profits of this nature realized as a result of the present excess income.

A corporation's income is divided into two parts: one representing no more than its normal earning power, taxed at 40 percent; and the other the excess profits, taxed at 95 percent. The two should not result in an over-all tax of more than 80 percent of the corporation's income. In most cases, 10 percent of the excess profits tax is provided to be refunded after the war. Normal earning power is the corporation's actual earning power during the four years preceding 1940 — various reliefs being provided to alleviate extra bad or extra good business years. Companies which had not reached a normal peak in earning power due to the fact that they were still in the development stage or for various other similar reasons, were given the opportunity to reconstruct their earnings and determine what their normal earnings would have been on the basis of years following 1940.

In order to obtain relief from these taxes an application for the relief must be filed, generally within three years after the original return has been filed. Ordinarily the corporation must pay its tax on the basis of the general formulae, no matter how high a tax it is, and then apply for the relief and refund thereafter, if it proves the merit of its case. Where it develops that more than half of the company's profits are in the excess profits area, the company is entitled, if it files its application for relief with its tax return, to anticipate part of the claimed relief. One third of the reduction in tax which it claims will result from the granting of this relief, may be deducted immediately from the tax. If later the claim proves ill-founded, that money must be repaid with interest. In many cases it appears best not to exercise that privilege of anticipation because of the vagueness of the subject. Only a small percentage of claims will be granted to a substantial extent.

Special publicity must be given to relief refunds granted under this section because of its vague and general nature. Because of its technical nature, the law provides for vesting exclusive jurisdiction to review the commissioner's determination in these cases in the Tax Court of the United States.

At the present time 37,000 claims have been filed — $12,000,000,000 of taxes being claimed in refund. However, if the money is returned, the company must pay an income tax on this money — which is termed as income. These relief provisions were intended only for abnormal and unusual cases and the reason for this large number is twofold: many taxpayers filed claims indiscriminately; and the claims extended as far back as 1942.

An important point very frequently overlooked is that, in many cases where the company has filed application for relief or is thinking about it, it will eventually turn out to be unnecessary. If the corporation, after the height of its wartime

profits, should have losses in the immediately succeeding years or should have profits below normal, so-called unused excess profits credits resulting, it may, by reason of carry-back of such losses or subnormalities in profit, be entitled to refunds on that ground alone and perhaps to such an extent that it will make claim for relief under these provisions entirely unnecessary. From a long range prospect we may expect to find that after two or three years of fumbling around of the bureau, weeding from these claims the non-meritorious ones, of finding its footing and establishing principles and procedures, meritorious claims will, if proof is available, ultimately get a reasonable measure of relief.

Resorcin resins and adhesives

PHILIP H. RHODES, Chief of Research and Production, Pennsylvania Coal Products Co.

Ever since the synthetic resin industry was started, it has been known that resorcinol will react with formaldehyde to give resins analogous to phenol-formaldehyde. However, until a relatively short time ago, the consequent resin formation was practically impossible to control. Research made it apparent to producers of resorcinol that if, in order to obtain an uncured intermediate, it was necessary to retard the progress of the reaction, it should be possible to effect the final cure of this intermediate with relative ease and that such a product would be of great value either as a casting resin or as an adhesive. Full details on the development of resorcinol-formaldehyde adhesives such as Penacolite G-1124 and G-1131, are detailed in the article "Resorcin resins and adhesives" which appears on page 160 of this issue together with lists of properties and proposed applications.

Chrysler plastics machine for continuous injection and extrusion of thermosetting plastics

N. J. RAKAS, Project engineer, Engineering Div., Chrysler Corp.

The Chrysler Corp., a large user of plastics, has pursued an extensive program on the development of injection and extrusion molding. The result of this work, carried on in the Engineering Laboratories, was the development of an injection and extrusion machine offering great possibilities. Promising results have been obtained with injection molding of thermoplastics and more work is being planned for these materials for future development. To date, most of the experimentation has been carried out with the injection and extrusion of thermosetting compounds. Complete details on the various machines that have been designed and constructed by Chrysler Corp. and its licensees together with information on sample molded parts, are presented in the article "A multi-purpose molding machine" which appears on pages 133-141 in this issue.

Outlook for the rubbers and the plastics

JOHN LYON COLLYER, President, B. F. Goodrich Co.

While the rubber and the plastics industries have always had a great deal more of mutual interest, technically, than has been generally realized, it seems likely that their activities and objectives will be more and more interwoven in the future. Already it is impossible to say at exactly what point rubber ends and plastics begin — the various synthetic elastomers, both thermoplastic and thermosetting, having bridged the gap between the rigid plastics and elastic vulcanized rubber.

Today, most rubber manufacturers are more or less directly in the plastics business with some non-rubber or semi-rubber products. In so far as B. F. Goodrich is concerned there is no fixed idea that any one commodity is the best for use in its many products. For example, the choice between natural rubber and synthetic rubber will go in any given case to whichever material proves to be the soundest economically.

One of the reasons why the rubber industry is no longer wedded exclusively to rubber is the great role that many plastics have played in helping mitigate the nation's critical wartime rubber supply situation. The strain on the nation's rubber stockpile, which dwindled from the Pearl Harbor level of 600,000 tons right down to the present rock-bottom "disaster level" of 190,000 tons, was vastly relieved by substitutions in which polyvinyl chloride and other plastic materials filled roles formerly served by rubber. Furthermore, the limited quantity of natural rubber that will be available during the next two or three years will make it imperative for the Allied Nations to use large quantities of synthetic rubber and plastics.

Immediately before our entrance into the war in 1941, rubber consumption in the United States reached an all-time high of 781,000 tons — a tremendous figure in view of the fact that consumption was only 4,000 tons yearly in 1870 when the B. F. Goodrich Co. was started. However, the figures on synthetic rubber are even more startling. In five years, from 1939 to 1944, the production of this material has increased from 1750 tons to 800,000 tons. In other words, the synthetic rubber producers achieved in 5 years what it had taken the rubber industry 70 years to accomplish.

While there will be considerable delay in obtaining anything like prewar quantities of natural rubber no matter how soon victory is achieved in the Far Eastern theater, there will come a time when the combined potential production of natural and synthetic rubber will begin to exceed demand. Then, under normal circumstances, these two materials would be in competition in a wide field.

Of course, two of the biggest of many "unknowns" in the balance of power between natural and synthetic rubber are the relative production costs and usefulness of these materials two or three years hence. At present, natural rubber is the better article for tires and other big-volume uses, but this situation is "subject to change without notice." The relative cost of these two materials is an involved subject for it is not a simple matter of comparing synthetic rubber at say 20 cents against natural rubber at 22½ cents. The processing costs for the two also have to be taken into consideration. And there is the added factor of "finished-product performance" to be taken into account.

Regardless of the economic factors involved in this coming competition between natural and synthetic rubber, our country should, as a national security safeguard, make sure of continuing a minimum production of 200,000 tons of synthetic rubber annually. This policy would afford the only workable means of assuring an adequate "war-proof" supply of this indispensable raw material.

The two main and, to a large extent, new materials for making synthetic rubber — butadiene and styrene — are being produced in enormous quantities to satisfy the wartime appetite for synthetic rubber. These materials may be lifted to an entirely new plane of importance in the general plastics

field on the basis of their availability after the war. With the manufacturing figures for polystyrene in 1944 listed as 400,000,000 lb., it is not surprising that this material is expected to be one of the important postwar plastics.

It might be said that the roles of butadiene and styrene exemplify the growing mutuality of interest between the rubber and plastics industry. Both should play leading roles in a new industrial era that will dawn out of the blackout of war.

BUTTON GROUP

Sound wage administration through job evaluation and proper incentives

GEORGE E. MEYERS, Manager of Special Service Department, Ernst and Ernst.

Day work and incentive wage rate structures and the administration policies thereof can be simple, understandable and practical if they are built on a sound and equitable foundation. However, today or at least during the present emergency there exists a "hodge-podge" of wage payment methods and structures which not only are misunderstood by employees but are difficult for management to administer.

Because of the "Little Steel Formula" as well as the "Wage Stabilization Act" of October, 1942, it was imperative that management devise some means of granting increases to deserving employees, minimize and entirely eliminate, if possible, existing inequities and provide a wage payment system that through a long range program would enable management and employees to eventually enjoy a wage rate structure that would be mutually agreeable and understandable. For this reason Job Evaluation came into its own.

The procedure followed in accomplishing Job Evaluation as developed by Ernst and Ernst usually incorporates five major factors. These factors, prevalent in varying degrees and representing separate requirements which must be met by employees assigned to the respective jobs, are: skill, which is weighted at 60.2 percent; responsibility, 14.8 percent; mental application, 7.4 percent; physical application, 7.4 percent; and working conditions, 10.2 percent. There are subdivisions of the first two factors, namely, skill and responsibility. Under skill we have: training, weighted at 12.6 percent; experience, 35.0 percent; and judgment, 12.6 percent. Under responsibility we have the responsibility for: equipment, 3.7 percent; waste, 3.7 percent; safety, 3.7 percent; and good will, 3.7 percent.

One of the first steps in Job Evaluation is to select an Evaluation Committee, composed, ordinarily of the plant manager, personnel director and possibly the head of the wage standards division. This master committee will not only assist in the development of the Evaluation Program but will act as a wage counselling committee for all future wage considerations. The Committee selects a representative list of key jobs preferably of varying skills and including about 10 or 15 different activities, and compiles a complete description of the job content and requirement for each key job. Thereafter these job descriptions are used by the Committee as reference material in evaluating the specific requirements of any job with respect to the ten basic factors heretofore mentioned. Following the complete point evaluation of the key jobs the remaining occupations are rated in the same manner.

The Evaluation Program serves as a very sound basis for setting rates of pay on new work and for general guidance in arriving at a sound wage policy over a period of time. In fact it is very difficult, if not impossible, for a company to administer any wage plan effectively without first going through a thorough process of Job Evaluation. The next step is to establish monetary rates of pay for the various occupations. In determining fair and equitable hourly rates for each of the Labor Grades — either a single rate or a rate range — the following should be taken into consideration: 1) the existing wage rates within the plant, 2) the going and tested War Labor Board rates of pay for the area in the area in which the plant is located, 3) competitive rates within the industry to which the product of the plant belongs, and 4) the straight time hourly earnings of incentive workers as compared to their respective base rates. When the top and bottom anchor points are decided upon, then the intermediate rate ranges or terraces are obtained preferably by geometric progression wherein each labor grade is a constant percentage higher or lower than adjoining grades.

The next objective would naturally be the establishing of adequate base rates by labor grades in order to arrive at a sound platform on which to build a fair and equitable incentive structure. In the language of the War Labor Board, an incentive system is "normal" if straight time hourly earnings exceed base rates by 20 to 30 percent. It is a "loose" system if these average earnings exceed 30 percent of the base rates. In the event of a "normal" excess the War Labor Board would favorably consider using the media of the day work range of each labor grade as the proposed base rates for all occupations falling within the respective labor grades. If the system is "loose" the minimum of the range of the various labor grades may possibly be used.

It would seem that the inequities and distortions in the wage rate structure and earnings of many plants could be overcome by paying, to every employee, the same percentage of earned premium over their respective base rates. On the average, taking all manufacturing plants into consideration, total plant labor is about 25 percent of sales. Furthermore, approximately one half of the labor payroll in the average plant is on an incentive basis. It seems somewhat unfair to operate a wage payment plan which enables approximately one-half of the employees to be paid supposedly for what they produce while the other half have no opportunity whatsoever to increase their earnings by initiative, increased effort or more conscientious application to their jobs. Therefore, if an incentive program can be applied to all the employees, then Management can control all labor costs and as a result pay better wages and still further reduce such costs. The plan should be so set up that all improvement in methods, processing, equipment or otherwise should almost automatically cause the factors to be adjusted so that management can realize, to the extent it desires, the benefits accruing from such improvements and changes.

In the discussion following Mr. Meyers speech the importance of good labor management relations was brought out. Without this basis, job evaluation cannot be successfully established. Personal experience indicates that it is extremely important to meet on an equal basis, a friendly basis. Mr. N. O. Broderson, adding a few practical details from his own job evaluation experience, made the point that grading of jobs seems mathematically difficult. Actually, once the job evaluation system is set up, a normal high school graduate can keep it in good condition. However, Job Evaluation is more than just a momentary thing. (*Please turn to next page*)

COMPRESSION GROUP

Practical aspects of radio frequency preheating as applied to compression and transfer molding

C. H. Frantz, Kurz-Kasch, Inc.

Preheating or tempering of molding materials prior to the pressing operation is not new. By this means it has been possible to improve the flow of the material in the mold, accelerate the close of the mold and cure of the piece and also reduce closing pressures. Although many advantages were obtained by this method the fact remains that molding materials, being insulators, resist heat absorption and therefore a preform so heated is considerably hotter at the outside surface than it is at the inside of the preform.

A common means for preheating is the double steam plate in which a layer of preforms is placed between the upper and lower plate. In such an oven, generally two or more complete mold charges are placed, depending upon the over-all time cycle. Time of preheat is from 5 min. up, depending upon temperature of oven and thickness and weight of material in the charge. Another common means of preheating is an oven with shelf arrangement. With it, either preforms on trays or the bulk powder in pans can be heated. These methods have been used for years and always will be, but in principle they are resisted by the material and today can be considered a good practical "has been."

Heatronics, which can be defined as the preheating of molding materials by means of radio frequency, has given us a method by which, for the first time in the history of molding, a charge of material can be heated nearly uniformly throughout its mass in a very small fraction of the time previously necessary. It affords instantaneous control for preheating at a very low cost.

The diameter, thickness and density of the preform itself are very important. They affect the three important functions of dielectric preheating — power factor, dielectric constant and shape. Single preform charges used wherever possible greatly simplify these variables.

The advantages of preheating are numerous. They consist of: precise control of preheating; shortening of the preheating time; much lower molding pressures; less or no washing of inserts; less mold distortion and damage; simpler molding cycles; fewer contraptions at press; simplified material loading; less material handling; slightly less loading weight required; lower plasticity required; fewer types of material required; less warpage experienced; no "weld" lines; minimized internal stress in the piece; uniform density of the piece; thoroughly cured piece; generally improved properties; more pieces per press and man hour; much faster cure, and better finish.

The principal disadvantages are: much slower preforming; the necessity for a radio-frequency technician at the plant and the need for additional floor area at press.

Clearly heatronics is still in the development stage; it is in a sense revolutionary. But it symbolizes just how research and development can materially change the course of our process — yes — of our business.

Refinement of product through control

Henry M. Richardson, Consulting engineer

The foundation for precision in molded parts is good molds accurately made, and a uniform compound. Having once established these things the rest of the job is in the hands of the molder who must: maintain the molds in proper condition; control uniformity of the weight of charge in compression molds; bring the compound to uniform condition before molding; establish and maintain uniform cycles of time, temperature and pressure in the molding operation; do an appropriate job of finishing on the molded parts; and set up a system of control to detect variations and check the outgoing parts to assure that the control was effective.

When we say good molds we mean those which will operate steadily without need for repairs and will produce uniform parts. But even before this we must be certain that the type of mold is appropriate for the job in hand. All types have their definite uses; the problem is to make the proper choice. This factor is often dictated by the types of presses which are available for the job under consideration.

Next comes the design of the mold to provide good flow conditions, to make parting lines come in the right places, and to foresee simplification of finishing operations. In addition, coring must be provided for sections to reduce curing time to a minimum, ribs and bosses must be selectively located, ejection pins must be in the right spots, metal inserts must be suitably anchored and sealed, and adequate support must be provided for long flexible inserts.

Following this comes the allowance for shrinkage of the compound. If standard allowance for shrinkage of the particular compound is made and the design of the mold is such that corrections can be made in the most critical dimensions after the mold has been built and samples run under normal production cycles, then the designer has done his best. These requirements are very important where close tolerances must be held because it is almost invariably necessary to make some corrections.

The other foundation for precise molding is uniform compound. By this I mean measurably uniform. Some of the characteristics of the compound such as bulk factor, pourability, volatile content, cure time and degree of cure have standardized tests for their evaluation. The flow or plasticity, however, as it varies with time and is affected by the speed of cure and the rate of heat transfer, is one factor which is not yet satisfactorily measured and controlled by enough of the compound manufacturers.

At this point we should consider the problem of providing uniform preform weights or uniform charges of loose compound. In compression molding we all know that if the pills are heavy the cutoff will be thick and the build-up dimensions will be high and if the pills are light the pieces won't fill out or will be low in density; if they vary from light to heavy in the same heat in a multicavity mold, some will be heavy and some low density and also the heavily loaded cavities will absorb most of the molding pressure. Here an investigation of pill weights is in order so that the most probable values and the deviation may be determined.

Let us carry this investigation further and measure some critical dimension on a molded part. If check heats are taken frequently on critical jobs they can be lined up to show any tendency for the critical dimension to drift toward one or the other of the tolerance limits or any individual cavities which fall out of line with their previous performance.

The same principle applies to finishing. Assuming that proper tools and methods for finishing have been established, then the control function comes in to check the initial production of new or changed tools or setups. Systematic follow-up will show how the dimension drifts with tool wear and

indicates time for resharpening or adjustment before offgage work is produced.

If the proper attention has been given to the control of parts during their manufacture by seeing that the mold is right and kept right; by purchasing uniform compound and keeping it uniform right up to the mold; by keeping uniform the molding cycle of pressure, temperature and time; by good tooling and setup for finishing; by attention to the training, supervision and compensation of the workers; and by a roving inspection in the factory which systematically checks the work at frequent intervals to detect drift or defects; then the final inspection may need be only by sampling to assure that the control was effective.

EXTRUSION GROUP

Standardization of materials testing methods

W. A. Evans, Bell Telephone Laboratories

Many different kinds of measuring instruments have been devised for measuring in different units and to various accuracies. Length measuring devices range from the common yardstick to the supermicrometer and Johanson blocks. Measurements of length can be made to an accuracy of a millionth of an inch. Weight measuring devices range all the way from platform scales for measuring coal and other materials in tons to the very sensitive chemical balance for weighing to an accuracy of a small fraction of a milligram.

For measuring small thickness of such materials as paper and films, for example, A.S.T.M. Standard Method of Test for Thickness of Solid Electrical Insulation D374-42 has been developed. In this Method A makes use of an adjusted ratchet micrometer together with a definite manipulative procedure by which the pressure on the specimen is controlled. Method B, known as the feel method, makes use of a machinists' micrometer constructed without a ratchet, pressure on the specimen being controlled by stopping closure of the micrometer where resistance to movement of the specimen between the instrument surfaces is first observed. Method C makes use of a dead weight dial micrometer which is constructed so that measurements made with it are practically the same as those made with Method A ratchet micrometer. Methods A and C may be used interchangeably.

For the reproducibility of test values in plastics it is necessary that the test specimens have a definite moisture content, therefore, conditioning under D618 is prescribed. The test properties in addition are: Water absorption D570, flexural strength D650, impact strength D256, tensile strength D651, compression strength D648, shrinkage D551, insulation resistance D257, dielectric strength D149 and dielectric constant, power factor and loss factor D150. All of these test methods referred to were formulated and made available in advance of writing the specification. However the form and object of the specification were always in mind so that the need for each method provoked its own formulation.

It must be kept in mind that almost all of the test methods must be capable of being used as reference tests. Therefore, reproducibility as well as ability to reveal the identifying characteristic for which it was designed, is of prime importance. When the identifying characteristic has been determined and likely test method proposed, samples or specimens are provided for a round robin test of the method by the interested participants.

A case in point is the present work of Committee D-9 of the A.S.T.M. which is the preparation of a specification on non-rigid polyvinyl chloride tubing or its copolymer with vinyl acetate used as electrical insulation. In approaching this task, what appeared to be identifying properties were listed. Some preliminary tests were made by several members of the Committee to determine their probable applicability. The list was slightly recanted. After several meetings and subsequent tests it is as follows: Color, sizes, flammability, brittleness — particularly at low temperatures — tensile strength and elongation, resistance to penetration at elevated temperatures, resistance to heat aging, dry dielectric strength, wet dielectric strength, insulation resistance, lengthwise shrinkage and oil resistance.

Test methods for some of these properties were available without modification. Methods for some were available but need slight modifications. Then for the remaining properties new test methods had to be formulated. The efforts of the Committee are now directed toward revising these methods.

When this standard specification, together with the necessary standard test methods, has been completed and is available, it should benefit both producers and consumers. The number of different standard sizes will be reduced as well as the number of grades. All of us will then be speaking in a common language in the handling of this item of commerce which has grown to very large proportions.

New trends in extruding equipment

W. J. Johnson, National Rubber Machinery Co.

Most of the items supplied to the Armed Forces have been made on equipment already in existence before Pearl Harbor, but despite manpower shortages and the diversion of engineering facilities, many important changes in design have since taken place. When the smoke of battle has cleared away, it is believed that better equipment will broaden the field for extruded goods. Some concerns anticipate extruding thermosetting materials, but our company cannot as yet promise anything outstanding in this particular field. We have installed numerous extruders for the manufacture of vinylidene chloride thread which has been used for making plastic screen for the Armed Forces in tropical countries, and other concerns are interested in the large-scale extrusion of this plastic for auto seat and furniture covers.

The manufacture of wide sheet materials is also expected to cover a broad field — with items that formerly were molded being blanked from extruded sheet as it leaves the machine. This extruded sheet will be economical since the lace scrap can be reused, whereas scrap from punched plate-polished sheet is sold at a fraction of its purchase price. The handling of short pieces is, of course, more expensive than the use of large reels of continuous strip as extruded.

Since no one knows just what the chemical concerns will next provide, equipment manufacturers must build machines which can be readily adapted for various groups of materials. For example, one 3½-in. plastics extruder has a cylinder built up of three sections. One section provides the right length for extruding rubber, while two sections are used with polyvinyl chloride and other rubber-like materials. Other materials requiring high temperatures use all three sections of the machine. Heads for the straight extrusion of rod, tubing, strip, etc., or for insulating wire are readily interchangeable merely by the removal of a king pin on which they hinge.

To avoid frequent breakdowns and extend the normal life

of the machine, hard corrosion-resistant liners are now standard equipment, and screws are hard surfaced and hollow bored for liquid heating and cooling. A customer buying an extruder for wire covering can readily change his extruder head for the extrusion of sheet, rod, tubing, etc. Such work as the covering of metal shapes or tubing, etc., can be done with new, improved and streamlined crossheads.

The rubber industry has many installations where two extruders are used with one head. These machines are arranged in an opposing position with the head and single die extruding the output of both machines. Two extruders with a common head mounted at an angle of 45° have been used in the rubber industry and could be useful with plastic materials.

Considerable thought has been given to the best method of heating plastic materials in extruding equipment. Extruders have been built for use with plant steam, self-generated steam extruders, oil-heated extruders and direct electrically-heated extruders. Plant steam is used for extruding materials such as rubber, synthetic rubber and polyvinyl chloride, while materials requiring higher temperatures have been extruded with the other three types of heat. The electric steam extruder consists of three small boilers for the individual heating of each cylinder section by an electric immersion heater suspended in a small quantity of water which converts to high-pressure steam. The oil-heated extruder which is most commonly used has an improved oil-heating system capable of removing heat as well as supplying it to the cylinder. For the extrusion of materials requiring higher temperatures, direct electrically heated machines should be considered, especially where frictional heat is not a problem. Improvements have also been made in the handling of extruded products. Conveyors are provided with additional advantages over previous equipment so that it will be possible to replace a conveyor belt in a few minutes.

For the wire covering trade more efficient accessories such as a combination capstan and water cooling box and takeup have been designed. However, the new development which has created the greatest interest is a 1½-in. plastics extruder, 12 ft. long, with all accessories for wire covering. The price and required floor space are about half of that of the usual larger units used for fine wire covering. In short, the equipment manufacturers are striving for flexibility, longer life with fewer replacement parts and more general satisfaction to the customer.

Plastic extruding in England and the United States

PAUL QUINN, Consulting engineer

At the outbreak of the present war, the British Government classified all manufacturing plants in terms of the facilities they possessed in good working condition and the labor facilities they could command. As a result of this survey, Paul Quinn, Ltd., with its stock of approximately 100 different die shapes collected through years of molding solid rubber tires, was entrusted with the job of turning out A.R.P. stirrup pump hose. The company's production of ½- and ⅜-in. hose was so satisfactory that, eventually, it was given a major share of all hose production in the country.

From experience gained in this war work as well as in the prewar business of producing a wide range of tires, the injection-type extruder does not seem to be an improvement over the screw extruder for work with natural or synthetic rubbers. This is due to the fact that under heat these materials only soften to a limited extent. Vinyls and acetates, however, if heated under medium pressure tend to turn quite liquid and, in such a state, are ideally suited for injection extrusion.

Although about the only development over the old type of rubber extrusion is a tendency to use a shallow and, consequently, longer screw, low-pressure extrusion has long been the ultimate ideal of many rubber and plastics technicians. The principal problem has been that of softening and, if possible, melting the plastic. Up to the present time, this has been attempted by conduction of heat. Since most plastics are among the best non-conductors available, the whole heating method has seemed wrong. It would appear that the use of high-frequency radio waves would offer possibilities along these lines. In this way, it should be possible to heat a given mass of plastic from the center outwards, thereby eliminating the high pressures and mechanical strain of the old type of screw extruder.

FABRICATING GROUP

In addition to the reading of papers by the Fabricating Group on Monday afternoon, Mr. W. T. Cruse, executive secretary of the S.P.I., opened a discussion on the possibility of organizing a Fabricators' Division of the S.P.I., and briefly described the services S.P.I. performs for its members.

A motion was made by Mr. H. Houston, Bolta Co., that a committee be appointed to explore the idea of organizing a permanent S.P.I. Fabricating Division and discuss the possibility of incorporating that division into regular S.P.I. membership. No chairman was elected, but the following committee was nominated and approved: R. F. Layton, Lusteroid Container Co. Inc.; Ted Swedlow, Swedlow Aeroplastics Corp.; A. S. Zimmerman, Bakelite Corp.; Mrs. E. Levien, Mastercraft Plastics Co.; Howard Yates, Hobbs Glass Ltd.; Irving Felsenthal, G. Felsenthal and Sons; M. L. Dinell, Clover Box and Mfg. Co. Inc.; C. H. Hunter, Hunter Plastics Co.

New developments in the fabrication of thermoplastic sheets

R. P. PIPEROUX, Chief development engineer, Celanese Corp. of America

When considering new uses for plastics, the following questions should be asked: 1) Will the new article be cheaper; 2) Will it be better or 3) Will it be more beautiful? If the answer to all three of these questions is in the negative then the project should be abandoned.

In addition to considering the suitability of plastics in a certain application, recognition must be given to the fact that along with their qualities, plastics have their limitations. One of these is the impossibility of manufacturing plastics items to metal tolerances. As to the choice of plastics, another variation arises. Some are better in one respect than in others. Again, the same material made under different formulations will have a range of properties where one member of the series would be adaptable and the other one would fail in a particular application.

Simultaneously with the improvements in the qualities and types of plastics, machinery was being developed for the production of items made of these plastics. In the molding field semi-automatic presses have gradually displaced the non-automatic press.

In the forming of sheet materials, machinery has not kept up with the progress of materials. Forming of sheet items by

automatic means is still very new — the equipment being the product of the fabricator himself. It is very necessary, however, that automatic machinery be used to produce items in quantities at low labor cost if competition is to be met. Just before the war a start had been made along these lines by several machinery manufacturers — work that was temporarily halted by military needs.

The use of sheet plastics in the making of transparent containers is an example of the promise this field holds out to the plastics industry. This is an ideal plastics application and one in which competitive materials are at a great disadvantage. In the first place there is the transparency of the material — the only competitor being glass which is fragile and heavy. And from the cost angle plastics will be able to compete, providing the methods of manufacture are such as to keep the labor cost down.

The types of possible containers might be divided into three classes: tubular container, folded boxes and the so-called drawn or formed container, while the tubular container might be further sub-divided into the longitudinal-seam type, the spiral-wound type and variations of these. The longitudinal-seam type is composed of a sheet rolled over on itself with a sealed or cemented lap joint. Before the war several machines were built to do this work automatically. All depended on forming the tubular section from a roll or thin sheet material which by passing through guides would gradually be rolled into a container, cylindrical shaped. When so formed and held, the web would advance continuously, be cemented in its passage and the cemented edge rolled down and held while drying. It is easily seen that such automatic means would have it all over the hand method.

The spiral-type of container consists simply of a strip of stock wound spirally and continuously on a mandrel while it is being continuously cemented in its progress through the machine. The machines on the market today are made primarily for paper purposes and their gluing arrangements are inadequate when cement is substituted.

Machines for the making of paper and cardboard boxes such as those used for eggs have been highly developed. However, because of the inherent differences of sheet plastic materials, the same type of machinery cannot be used without modification. Since the scoring of material is impractical — usually resulting in cracking of the stock — it has been necessary in most cases to do the bending hot. Recent developments have shown that the application of electronic heat locally in a fine line is perfectly possible.

Still another method of manufacturing transparent containers is by the so-called drawing or forming method. It is in this type of container that most progress has been made recently in automatic production means. War demands for small ammunition containers made it absolutely necessary that some means be found to manufacture small containers at high rates of production.

Up to about 3 or 4 years ago such containers were made on so-called hand presses in which a ram, actuated by means of a handle to reciprocate between guides, force-pressed the material into a die. A necessary adjunct of this method of forming is the so-called hold down or stripper plate, the function of which is to keep the material smooth while it is being drawn into the die. There were quite a number of defects in the operation of this unit. Very often the stripping fingers would fail to act, the formed box would return with the force and there was considerable delay while the operator manually tore the recalcitrant box from the force. Any delay in operation would cause the plastic sheet between the die and the hold-down plate to become overheated and stick.

There had been attempts to make such containers with the usual type of punch press, but most of these applications were unsuccessful. When war came and these little containers were required by the millions for ammunition requirements, some way had to be found to solve the problem of producing them with speed and efficiency. A little piece of apparatus was rigged up so as to show on a chart exactly what the operator did. From the information gained from these charts it became apparent that it was desirable to duplicate, as much as possible, the action of hand forming, and that the easiest method of performing this was by means of cams which could be cut to give the ram any type of motion desired. Since boxes vary in depth, and adjustable cams were out of the question, it was decided to make simple contoured cams which could be cut to shape on a precision hand saw.

Presses of this kind have been in service now for several years and have manufactured small ammunition items up to a rate of 90 per minute, whereas equivalent hand operation had a top in this particular piece of about 15. Further, since an operator can now very easily watch 4 mechanical presses, the production per operator has been at the ratio of 15-360 or aproximately 24-1. Some difficult pieces are made at rates of 30 per minute but the ratio of machine production to hand production is still very great.

There is a necessity for machines which would be adaptable for the fabrication of sheet items in large quantities to displace the more or less antiquated hand methods which remain and it is up to the fabricators to become so insistent upon their development that the machine manufacturer cannot afford to overlook their demands.

Cast phenolic resins; their properties, styling, fabricating, and where they should be used

A. S. Zimmerman, Bakelite Corp.

Since the invention of cast resin by Dr. Backeland in 1907, a great deal has been learned concerning the chemistry, color and machinability of cast resins, and considerable progress has been made. Techniques have been developed to improve casting so that it is possible to cast large pieces with undercuts.

Cast phenolic resins are furnished to fabricators or manufacturers in rods, sheets, cylinder, or in special shapes designed to approximate the contours of the finished articles, thus reducing fabricating operations in the production of the finished piece.

Regular machine shop equipment is used in producing parts from cast plastics. In quantity production of parts, operations similar to those applied to metals such as drilling, turning, threading, tapping and milling are performed under conditions adjusted to the nature of the material. Some of the machining operations, which Mr. Zimmerman illustrated with slides and discussed, include automatic abrasive forming, lathe and screw machine production as mentioned above, carving, cutting, jig sawing, band sawing, circular sawing, grinding, shaping and sanding, die cutting, polishing and buffing operations, and tumble polishing.

Full description of these operations as well as the drawings shown on the slides will be found in the 1945 Plastics Catalog article, "Machining Cast Resins."

Mr. Zimmerman explained what was good and bad practice in these finishing operations and displayed samples and

photographs of simple fabricated products, as well as a few large and complex formed and cast shapes.

Printing inks for use on plastics

J. J. Micik, Control Lab., International Printing Ink, Div. of Interchemical Corp.

The major printing methods presently in use for the application of printing inks to plastics materials are typographic, lithographic, aniline, intaglio and silk screen. Since each and every one of these processes use a different type of ink, it will be the problem of the plastics fabricator to choose the method best fitted for his particular purpose.

In typographic printing, ink is applied to the raised printing surface by means of a series of rollers which conduct the ink from the ink fountain to the printing surface. Since there is a time lapse in the transfer of the ink from the fountain to the printing form, a type of vehicle must be selected that will not dry by rapid evaporation. These inks must be formulated entirely of oxidizing materials which solidify or polymerize by the absorption of oxygen from the air. Such oxidizable inks are applicable to various types of printing where drying time is not too important.

Lithographic inks are similar in construction to typographic inks, except that they must have higher consistency, higher pigment concentration and a narrower range in choice of vehicles. In lithography, inks pass through a series of rollers on their way from the ink fountain to the planographic printing surface and have, therefore, the same limitations as typographic inks insofar as drying rate is concerned.

Aniline printing is basically a typographic form of printing. However, this process utilizes low boiling volatile solvents which evaporate within a few seconds of application to the printed surface. This method of printing uses but two rollers in its application, making press stability a minor factor.

In intaglio printing, the method and the inks are quite similar to aniline, except for the fact that the printing plate is an intaglio engraved copper or chromium surface across which a doctor blade is drawn to remove the excess ink. According to our present knowledge this method is quite limited for the printing of plastics.

Silk screen printing on the other hand utilizes inks of both oxidizing and evaporating types. The imprint is made by squeezing ink through the pores of a silk-screen by drawing a rubber squeegee across the surface.

While each of the methods may have some similarity in their process, they use entirely different inks and, therefore, present entirely different problems. Letterpress inks consist of insoluble organic and inorganic pigments ground in bodied drying oils, oleoresinous vehicles and synthetic resins, such as alkyds, phenols, ureas, vinyls, etc., or combinations thereof. Formulas are adjusted to meet requirements such as binding, drying and any other specification that may be encountered. Lithographic inks are of similar construction but contain a higher pigment content and more viscous varnishes. Limitations in the choice of pigments and resins in these inks are due to the use of water in the printing process.

In aniline inks, oxidizing vehicles are entirely eliminated and restricted to such materials as shellac and resins dissolved in various types of synthetic solvents. These inks must dry almost instantaneously because the printed materials are either re-wound or processed immediately. In the main, aniline and rotogravure methods are used for the printing of cellulose acetate and cellophane.

Inks adapted for silk screen work are divided into oil, water color and synthetic types — the synthetic type being most suitable for plastics. The varnishes adaptable for manufacturing silk screen inks can be classified as oleoresinous, or binding ingredients including nitrocellulose, ethyl cellulose, alkyds, phenol-formaldehyde, vinyl, methacrylate, polystyrene resins, etc., dissolved in some of the synthetic solvents either individually or in combination, depending upon the plastic to be printed and method and time of drying.

There seems to be a demand at present for silk screen inks for plastics which have quick drying properties. Two kinds of inks can be formulated to meet this requirement, but the type of plastic must be taken into consideration before the inks are formulated. This is understandable since a thermoplastic material would not permit accelerated drying.

Although liquid inks used for marking and stamping nonporous materials such as plastics are classed as specialties, the volume of their consumption has increased, and many ink manufacturers have spent considerable time and research in their development to meet the demands of the plastic fabricator. Liquid stamping inks can best be applied by stencil brush, rubber stamp and pad, or some mechanical application which is generally designed to feed the liquid ink from a closed perforated cylinder to felt or rubber distributing rollers which ink the raised type that contacts the material to be printed. Inks for this work are composed of materials similar to synthetic silk screen inks except that dyestuff colors are used in place of pigments.

The most important factors governing the application of printing inks to molded or extruded plastics are the physical characteristics of the plastic surface, and/or, mechanical and chemical resistance to an ink film. The physical condition of the plastic surface governs the adhesion of the ink film. If the ink does not penetrate sufficiently, there is a consequent lack of binding. Mechanical resistance of the ink film to its anchorage is often caused by climatic conditions and by bending or flexing movements which result in ultimate peeling. Adhesion of the ink film is also controlled by its permeability to carbon dioxide or water vapors.

As many of the fabricated plastics are used in the manufacture of motorized equipment, radio and electrical appliances, the ink must usually comply with specifications that require resistance to gasoline, motor oils, hydraulic oils, deiced fluids, alcohols, acids, alkalis, etc. It is absolutely important that these factors be stated by the plastic fabricator so that the proper ink will be submitted.

INJECTION GROUP

Polyethylene

Dr. J. W. Shackleton, E. I. du Pont de Nemours & Co., Inc.

A plastic material with excellent electrical properties, polyethylene is a hydrocarbon resin made by the polymerization of ethylene. In its uncompounded state it has a waxy white, translucent appearance, but it may be made transparent in thin sections by quenching. A thermoplastic material, polyethylene can be readily molded by injection or compression, or extruded to form sheets, films, fibers, tubes and the like. In thin sections it may be classified as nonrigid, yet it lacks the limp rubbery quality that character-

izes most nonrigid plastics. In thick sections it is often stiff enough to be classed among the more rigid materials.

Its outstanding properties — flexibility and toughness over a wide range of temperatures, good resistance to water and to penetration by moisture, chemical inertness and excellent electrical properties — should find it a place in many important electrical and industrial applications.

Complete details on the properties and possible application of this material appeared in the article "Polyethylene — a new thermoplastic" which appeared on pages 178-179 in the February 1944 issue of MODERN PLASTICS (Ed.: Other articles dealing with this plastic are "A new dielectric of cables" in the July issue of this magazine, and "Polyethylene" in the August issue.)

Cerex and Styramic HT

C. L. JONES, Monsanto Chemical Co.

The principal handicap facing the injection molder of thermoplastics has been the low heat resistance of these materials. Such a limitation has restricted the use of these plastics in three important applications — contact with boiling water, industrial jobs requiring moderately high temperatures and requirements of form stability to withstand heat generated by the product. However the advantages of thermoplastics and the rapid, economical production rate of injection molding have been sufficient to warrant their continued and wide use despite these limitations.

It is with high hopes, therefore, that the plastics industry has welcomed the development of two new thermoplastics having high heat resistance qualities in addition to those other properties that have made thermoplastics popular. These materials — Styramic HT, or chemically, polydichlorostyrene, and Cerex, a material closely approximating the mechanical properties of polystyrene, are already in commercial production. Formulations of the latter have heat distortion points from 195 to 300° F., while the former has an A.S.T.M. rating of 236° F.

A comprehensive analysis of each of these products has already appeared in the pages of MODERN PLASTICS. The August 1944 issue contains the article on Styramic HT under the title: "New high-temperature styrene" (page 93); and Cerex appears in the July 1944 issue, entitled: "A new series of thermoplastic resins" (pages 83 to 84).

Considerations in the standardization of injection molds

L. J. MORRISON, Detroit Mold Engineering Co.

The miraculous results of standardization and specialization in other industries are so commonplace, we take them for granted. Our standard of living is the highest in the world because we have been able to utilize mass production so as to give us better products at lower prices. This then is the American genius — to know how to standardize and to produce.

In view of these facts it seems strange that the plastics industry has been slow to standardize. Plastic items have long ago been standard in many businesses, but within the industry itself the development of new materials and new processes has been so fast that standardization has gone begging. Another retarding factor has been the relatively small sized shop of most of the fabricators of plastics materials. These shops do not have the volume of business that encourages industry-wide standardization. Likewise, they are less prone to pass out information and more likely to guard their production methods. Fortunately our common knowledge is increasing with the growth of industry and we seem on the verge of a period of standardization.

The place where most of us could begin standardizing is in our tooling program. The first thing to be done on this program is to develop a common nomenclature so that in our conversation and correspondence relating to our tools and machinery we can be perfectly intelligible.

Second, consider the tools for an injection molding shop. Is it possible to use all of one make of injection press in order to standardize on equipment? This is better from the standpoint of spare parts but not always to be recommended. One press may be ideal for fast cycles and light work and another may be ideal for heavier work. Thus there may be several makes and models in one department. However, certain things should be standard on these presses. The nozzle radius should be identical. The holes in the platen for locating the molds should be a minimum size and standard. In other words, there should be no feature on a press that would prevent molds being interchangeable.

From figures obtained in a survey of three custom molders, 75 to 80 percent of the work may be expected to fit into a standard setup, the balance of the molds being too complex mechanically for standardizing.

It is necessary, therefore, to determine on a standard shape for our molds. Practically speaking, this resolves itself into a choice between a round and a rectangular mold. Any other shape is a complication of either of these and serves no generally useful purpose, although occasionally it is convenient to cut off the corners of a mold to provide clearance for a strain rod and sometimes molds take the shape of a polygon in order to have core pulls in more than four directions.

The next thing to consider is the matter of material for the mold. Mild steel plate has been used in the majority of cases because it is universally obtainable in any shape or thickness. A few warehouses carry high carbon plate SAE 1040 which has about 20 percent greater strength than mild steel but is more difficult to obtain. If the program anticipates only 50 molds per year, the requirements would hardly be sufficient for a special order from the mill, but if 500 molds are anticipated the possible economies make purchase of a specific steel from the mill essential. The middle course would seem to be SAE 1040 since it is stronger than mild steel and only 10 percent more expensive.

In determining what size to make the mold once again the number to be made must be taken into consideration. If the plan is to standardize on only the needs of one shop, then the sizes should not exceed two. If the standardization is on the basis of the needs of the industry, a greater number of sizes can be made. For a minimum size, a square mold no smaller than 8 by 8 inches for single cavity jobs is suggested. The next size should be of medium width and length — say 9 x 12 or 10 x 14 inches to fit the 4, 6 and 8 ounce presses. The third size should have the width raised to maximum and the fourth size should have both maximum width and length.

In addition to the consideration given to the mold itself, the importance of the various elements which contribute to its proper functioning should not be overlooked. Such parts as ejector boxes and pins, dies, clamping plates, space blocks, leader pins and the like, each have their specific functions

and unless equal attention is given to their construction in relation to each other and to the mold itself, no amount of standardization on the mold proper will have any real significance.

Silicones — a new class of high polymers

SHAILER E. BASS, Dow-Corning Corp.

A new and almost revolutionary class of high polymeric substances have come into being as a result of research in the field of polymer chemistry. These new heat-stable organo-silicon oxide polymers are available in several physical forms, including fluids for use over a wide temperature range with little change in viscosity, chemically resistant greases, insulating resins and high-temperature lubricants. They are characterized by heat stability, inertness to water and chemicals and excellent dielectric properties — characteristics which are in large part due to the fact that they are built upon frameworks of silicon atoms joined to each other only through oxygen atoms, a structure previously known in high polymeric materials only in the completely inorganic high polymers.

A detailed study by Mr. Bass and others of the history, formation, uses and future possibilities of silicone resins can be found in the November 1944 issue of MODERN PLASTICS magazine (pages 124-6).

MACHINERY GROUP

Molding machine pumps and their circuits

M. E. ENGEBRETSON, Advertising manager, Oilgear Co.

In considering the application of fluid power to plastic molding equipment, a brief analysis of old hydraulic plants and the history of the development of such devices should prove helpful in visualizing the functions and many useful features of modern fluid power equipment.

About 1785 an Englishman, Joseph Bramah, discovered cup-packings for pistons and thus invented the hydraulic press which was operated with a hand pump. This machine, which was slow but highly efficient, immediately took hold in England due to the spectacular way in which large forces could be obtained. However, to obtain more speed and power, power-driven pumps were next used. This system was also highly efficient — power being used directly in proportion to the work being performed, except when the necessity for the control of the ram speed arose, requiring the use of a throttle valve to bypass the excess liquid delivered by the pump. Under such conditions of operation, positive control of the press ram movement was lost and power was no longer proportional to the work performed by the press piston.

In 1850 another Englishman, W. G. Armstrong, invented the accumulator to store a large amount of fluid under an artificial head. The use of an accumulator permitted the use of a small power-driven plunger pump — slightly larger than the average power demand — to store up fluid power in the accumulator so as to have large amounts available for the intermittent operation at high speed of machines such as presses and forging machinery. The accumulator brought with it the need for throttling the fluid which made such installations subject to excessive maintenance.

For many years, however, engineers had considered the possibility of dispensing with the accumulator and going back to the first hydraulic principles because of the uncertainty of control, the shocks and damage to the system from the accumulator and throttle valve and the extravagant use of power. That possibility was opened up by the development of the high-speed variable delivery pump using a high-grade lubricating oil as the fluid power medium. This pump discharges large quantities of fluid under high pressure when required and graduates the amount delivered in proportion to the position of a control mechanism and without practical regard to the pressure against which the pump is operated at the instant.

Characteristics inherent in these fluid power units and standardization of design make possible the use of a wide variety of controls to provide the host of functions required on molding machines. These controls are an integral part of each pump and operate directly on the slide block.

By consolidating the ingenuity of the molding machine and pump manufacturer the result was a conventional line of plastics injection molding machines which provide the following fluid power functions and features: 1) Pumps are arranged for direct drive and start under no load. 2) Inching control of all functions for setup purposes without disturbing present cycle control setting. 3) Each ram can be operated independently with manual control. 4) Clamping force on injection platen is always constant irrespective of variations in nozzle lengths. 5) Clamping and injection forces remain constant irrespective of ram speed selected. 6) Clamping and injection forces can be varied to suit work performed. 7) Clamping and injection pressures are registered on direct reading gages. 8) Rams can be stalled under full load indefinitely without damage of overheating. The pump volume and power input is automatically reduced to a point just sufficient to maintain the pre-set pressure in the system.

Allocations of plastics machinery

JAMES A. LAWSON, Chief, Equipment Branch, W.P.B. Talk delivered by Joseph D. Houghton, Asst. Chief of Facilities Branch, W.P.B.

About 75 injection machines are scheduled to be allocated in the first quarter of 1945. This compares with the 60 odd machines allocated in the last quarter of 1944. There were 3 times as many requests as there were machines for the last allocation; the machines you want aren't made yet. Included among the machines to be allocated are thirty 6- to 8-oz. presses and the balance will be of larger capacity including at least one 22-oz. machine.

The thermoplastics industry is now being allocated 5,500,000 lb. of acetate and butyrate, 1,000,000 lb. of polystyrene and 660,000 lb. of other material monthly plus 1,000,000 lb. of scrap which was going into the hopper. Figures indicate that the industry, as now equipped, is handling that amount of material without too much trouble.

An outline of the allocating policy of the Facilities Branch, indicates that W.P.B. will *not* allocate machines for production of civilian goods not made before the war and that practically the entire 70 machines will be allocated primarily for war goods or to plants engaged heavily in war business.

The bottleneck in machinery production is still manpower, motors, pumps and other component parts. As soon as these shortages are overcome W.P.B. will permit expansion as rapidly as possible, provided there is no expansion with the war effort. Officials do *not* want to prevent new business but indications are that the Branch favors a policy of withholding machines from brand new enterprises until the older, estab-

lished firms who are now in war business, can get theirs. There will be some conflict with this theory because the Government over-all policy is to encourage maximum employment and machines for civilian goods which may eventually be placed with new companies in areas of low labor employment in order to put people at work, but by and large the policy of the Facilities Branch is to consider the "old-timer" first.

When plastics come home from the wars

COL. WILLARD CHEVALIER, Publisher, *Business Week*.

Despite the fact that the splendid record of plastics in World War II has served as the best possible advertisement for these materials, we cannot get away from the fact that after the cessation of hostilities the plastics industry will still need to employ sound principles of advertising to maintain the gains made in the field of essential materials.

Because of the great attention paid to filling the demands of war, the peacetime possibilities of plastics are virtually untouched. A broad field of new markets will be available in the postwar years. This fact, combined with the wide publicity which has been given to the new applications which have been uncovered by wartime uses, has developed a feeling among a considerable part of the public that plastics will be the number one panacea for the postwar world. Therefore, it seems that some education of the public on exactly what plastics can and cannot do should be a major part of your postwar merchandising program.

Marketing primarily is a job of keeping the customer satisfied and, to an outsider, it would seem as though one of the biggest difficulties in marketing plastics is the very word "plastics." The word covers a wide variety of materials, each with different characteristics and each especially adapted for a particular purpose. An effort has been made to meet this difficulty by the use of trade names to differentiate between the various chemical families of plastics, but the generic term still sticks in the mind of the public. That is why merchandising research must hold an important place in the postwar planning of the plastics industry.

A recent survey of materials employed by a number of manufacturing plants showed plastics ranking fifth among the twelve materials included in the survey but first in anticipated further applications. A great number of the users of plastics and some non-users anticipate the use of these materials in the future, but some percentage of the users and a larger group of the non-users are still undecided. One factor for this indecision may be that the survey brought to light a wide lack of knowledge of the best uses of the special characteristics of certain plastics. Since these are the groups in which a great potential market increase lies, it is the place where the educational program is most needed.

Parallel with the above survey was one conducted by MODERN PLASTICS among members of the plastics industry. This survey indicated that more than half of the plastics molders plan to increase plant capacity to meet anticipated peacetime demands. This revelation, coming as it does at a time when some segments of industry are frankly worried about being overexpanded might lead an outsider to believe that you, as a group, are over-optimistic. But, this plan seems to be well justified in the light of the results mentioned in the first survey.

As young as the plastics industry is, it has to prepare to enter the postwar production field and meet the competition not only of the old but of a number of other new materials that were not available in large quantities or at suitable prices before the war. Everything that one reads and hears indicates that the industry is looking ahead. But it is no short-term task. The industry will not stand still once the transition from war to peace has been accomplished. It will either go ahead, or it will go back. It may go ahead and still not make progress unless it keeps ahead of the normal increase in population, the normal increase in efficiency through new machines and new processes.

It has been said that there is no more perishable commodity than an established product. The job of selling consists of putting a product into the hands of a consumer. But it takes aggressive promotion and education to keep a product in the public eye, and there must be aggressive improvement, always a little bit ahead of the aggressive promotion, if a product is to hold its place. The best available protection for any industry is to outmode its own product, then make plans for the future. But, if a competitor, through research, promotion and education, makes his rival's product obsolete, these postwar plans may never have a chance.

The plastics industry has gone through the period of primary research in the production of its basic chemical compounds — its raw materials. Costs have been cut through improved machinery and new processes in the production of plastics, in molding and fabrication, so that plastics may compete in markets previously denied them. As a result of the speeding up of tests and materials during the war, uses have been discovered for plastics that were not dreamed of a *few* years back. This sudden expansion undoubtedly has put the industry ahead of its normal development, but there can be no resting on the oars because of a job well done.

The need for selling has not changed since the day when men first discovered that they could produce more by working together than by working alone. The need for education of the customer has been with us from the day the first sale was made. The need for research and improvement has been continuously evident from the time of the first crude invention. The need for keeping a product in the public eye has been apparent since the first producer discovered that a market vanished because another producer had filled the demand during a layoff or had turned out a better product. All these are fundamentals that cannot be discarded, and the need for intelligent application of these fundamentals has never been so great as it is today.

What the retailer expects of the plastics industry

LEW HAHN, General manager, National Retail Dry Goods Association

When a retailer thinks of what lies ahead in his field, plastics very definitely appear on the horizon. He shares the general opinion about plastics — that this industry is going to provide him with a great many new articles and he believes that many of these articles will be distinct improvements over those made of other materials.

The plastics industry, however, has been somewhat oversold and that is a serious thing, since if a customer expects too much he is going to be disappointed. The industry has a great future but we are probably going to see a great many

things which shouldn't have been made of plastics or of the particular type of plastics of which it is constructed.

From the start the public should be told the truth about plastics. Instead of basing sales upon the old law of "let the buyer beware," the byword should be "let the vendor beware." It would be an excellent thing if the plastics industry came to a system of informative labelling, so that consumers could distinguish between the different types of plastics which may be on the market and what could be expected of them.

We have before us, both in the plastics industry and retail trade, a very great problem. We're going to have to provide a great many jobs when this war is finally over. Every man going into the production industries is going to want to produce the last unit of which his plant is capable. If we produce, there will be jobs. But we can't unless we sell, unless we can get that merchandise quickly into the hands of consumers. Consequently, we must recognize that a greater problem than production is distribution, and distribution will be possible only through thoroughly acquanting the public with these materials.

It isn't being over-optimistic to say that there is a great future ahead for the plastics industry. This fine organization is evidence of the fact that its leaders are looking ahead, realize possible pitfalls, and are doing everything possible to control them.

MERCHANDISING FORUM ON PLASTICS

At two-thirty o'clock on the afternoon of Tuesday, November 12, a merchandising forum was conducted between members of the plastics industry and editors of various magazines representing potential plastics markets. James R. Turnbull of Monsanto Chemical Company presided as chairman, introducing the following speakers: R. H. McCready of *Playthings Magazine;* Archer E. Knowlton of *Electrical World;* Julien Elfenbien of *Housefurnishing Review;* Dr. O. H. Caldwell of *Electronics Industries;* F. H. Waggoner of *Premium Practice* and *Business Promotion* and C. W. Browne of *Modern Packaging.* Essentials of each speaker's address follow.

Mr. Turnbull opened the forum with a definition of merchandising as the science of who buys what, when, where and why. The early years of S. P. I. were largely devoted to devising new and improved materials and better methods of manufacture, he stated, but from now on the industry is going to be concerned almost equally with three problems — materials, methods and merchandising. Realization of the bright future of plastics depends as much on the soundness of merchandising policies as it does on technical advances. More and more, working and thinking will have to be in terms of quality, performance, customer satisfaction and value. It is because of such facts that the merchandising forum was planned.

R. H. McCready — There are only three basic industries whose customers include every man, woman and child in the country. These are the fields of food, clothing and toys. The toy industry differs from those of food and clothing in that it never encounters a saturation point. In the toy industry a new customer is born every ten seconds. He comes into the market without prejudice and with an eager desire for whatever he sees. Here truly is fertile ground for new things as well as old. During these early years of first impressions, many lifetime habits, likes and dislikes are formed. Knowing this, many manufacturers supply miniatures of trade-marked goods to be sold throughout the toy stores, so that when a child grows up, it will know what such products do and how reliably they can do it.

A new era in toy marketing is at hand and sales will show a phenomenal increase during the next few years. The growth of plastics will have a great influence in bringing out this result. Plastics will undoubtedly find many uses in the toy industry. In spite of severe war restrictions, their use has steadily expanded. It has been necessary to use second-hand material but in spite of this, remarkable progress was made. While plastics cannot replace certain intrinsic qualities in other materials, they will have their place and it will be an important one. However, they must fight for what they hope to get.

Archer E. Knowlton — The electrical market for the postwar electrical appliances for the household is, correspondingly, as large as those of housewares, toys, novelties, containers, radios and electronic devices. The demand for replacements and new items is enormous. The types and kinds of electrical items are so varied that they offer an opportunity to sell something to every second man, woman and child in the country. How much of the volume of sales in the past has been in plastics is uncertain, but there is hardly any one of the items that does not offer a place for plastics.

The kind and quality of plastics that are wanted for the prospective electrical market are as varied as they are for other fields. And in addition, there is the extra requirement of moderately good electrical properties. Most plastics can meet the average electrical specifications except in the field of motors, transformers, circuit breakers, and the like, where requirements are exacting.

Ultimate users of electrical equipment do not buy plastics any more than the purchasers of electrical appliances buys them. Both buy an electrical device in which it is merely a component. But in the case of the former group, if the equipment fails to carry the load, overheats, breaks down or has a short life, a technical curiosity is aroused. Consequently, there has been a healthy interest evinced by electrical men in plastics. They want that degree of reasonable familiarity that leads to confidence. There is one thing, however, that they know nothing about — it has to do with the constancy of the product. Will plastics manufacturers always conduct their operations in exactly the same way, use the same ingredients, add the same control agencies, and if not, will the electrical performance vary? The way, therefore, to win further acceptance for plastics in the electrical power field is to be specific in asserting the superior electrical qualities of plastics, and the way to hold that acceptance is to give continuous assurance of permanence, stability, constancy or progressive improvement of an accepted line.

Julien Elfenbein — Market opportunities for plastics in the field of home furnishings were discussed using a department store as a basis for analysis. Such a store divides all of its merchandise into two main groups: home furnishings and body furnishings. The latter are sometimes described as "fashions." The former, being more complex, have a number of subdivisions which in turn number as many as twenty thousand classifications. Among that number there are few items that could not find some application for plastics.

All house and home furnishings divisions have a buyer who serves as a consultant on the staff of the American housewife. The buyer is the person to whom you will sell your plastics

products. The plastics industry may hire advertising counsels and public relations counsels to sell their products, but until it can talk commonsense to the housewife's consultant it will not be able to achieve a sound or profitable basis in the furnishing field. The retail merchants, through their buyers, are going to make certain that the plastics products you ask them to buy are honestly and clearly represented. The mountain of technical information, testing specifications and test methods compiled by the plastics industry is not going to be clear to these people unless the information is divorced from the highly technical language of the trade and reduced to everyday terms. There will have to be, therefore, a system of informative labeling devised which, combined with the name of a reputable manufacturer will give credence to the claims made, and bring a full measure of plastics business with the home furnishings industry.

DR. O. H. CALDWELL — The electronic field was presented as the sister glamour girl to the plastics industry. This industry, which is simply a new term for radio and communications, represents a billion dollar field in which plastics finds many uses and will find many more as electronic engineers become better acquanted with plastics. The electronic art is complex, and even the best engineers cannot keep track of its development. Therefore, few of them will have the time or the interest to delve too deeply into the problems associated with each kind of plastics. Again, the highly technical language of plastics proves a barrier to the plastics layman, so that the electronic man's selection of a certain type of plastic is limited mainly to his previous experience with or knowledge of a definite material.

It is not surprising, therefore, that a general educational program is necessary, starting with the basic information that there are as many varieties and types of plastics as there are metals and alloys. In the case of an electronic tube it is simple to select the proper type from the three or four thousand available because data sheets contain all the most common data for tube circuit design. The plastics data, on the other hand, is specified as ranges of values and is thus not specific enough for the designer's use. Until the characteristics of all types of plastics ultimately succumb to the orderly eye of the scientist it will remain the task for the sales representative to interpret the engineer's need. He is well informed in the physical characteristics that he requires and has full facilities for measuring quantities when plastics are tested.

In the postwar era, frequency modulation and television as well as many commercial and public communication services employing the newly-developed frequencies will require special forms of cable and insulation materials. Plastics are candidates for this job. In fact, almost all of the postwar applications in this field will contain plastics components. Such components will consist of, for example, heat-tempered wood, plastic foam for sound insulation, optical mirrors and lenses having large apertures, decorative laminates, metal-plated plastics and hot-spray synthetic rubber covering. It is up to the plastics industry to give full information on the processes and conditions of these materials to the electrical and technical press so that the engineers will be prepared in advance with a working knowledge of the benefits available to the electronic industry from plastics.

F. H. WAGGONER — The presentation of the case for the premium and advertising specialties began with the fact that merchandise that is already on the market depends for its sales volume on consumer acceptance. Merchandise not already on the market will depend for its sales volume on the propaganda that is put behind it. Such a condition is peculiarly adaptable to the plastics situation because people believe that we are on the verge of a wonderful plastics era. Plastics propaganda might well be directed therefore to the field of premiums and advertising specialties which in the years before the war used merchandise of a total dollar volume of 500 millions, and in postwar years will be intensified as never before.

No selling and advertising device yet brought out has a comparable power to influence preference for one product over another and to hold that preference as premiums. Not only are many of the country's leading concerns premium users, but others equally great are getting ready for sales to premium users. The plastics industry has already discovered the untold possibilities for sales in the premium field, not only in premiums made solely of plastics but others embodying plastics parts. Its real problem now is to discover the several thousand other concerns, each prominent in its own territory, who use premiums and the thousands more who represent great potential outlets. That discovery usually comes as the result of advertising in the proper trade media.

The quickest way to kill the use of plastics in the premium field is to have some good big campaign fall through because the premium did not stand up. No hunger for business at any time can justify taking a premium order where the material used will not meet all of the requirements of a satisfactory piece of merchandise. Linked with this is the temptation that must be overcome to quote prices so low that in order to make a satisfactory profit, there must be a skimping in materials. Bearing these things in mind, the plastics industry should further every effort to corner the tremendous postwar market in this field.

C. H. BROWNE — This final discussion outlined the role of plastics in the packaging field. This industry has four functions which are the fundamentals of any packaging program: protection, convenience, economy and appearance. The first function requires materials which are substantial enough to deliver the product to its ultimate consumer in first-class, usable condition. The second involves ease in handling, the third, the factor of proper proportioning of cost and the fourth, the combination of elements of color, design and visibility with the complete identity of the product.

The plastics industry must keep these four functions in mind in seeking the packaging markets as an outlet for its materials. Then, it must be fully cognizant of the properties of its own products. Finally, it must learn enough about the customer's particular product, his marketing plan and his ultimate consumers so that it can go to him with valid packaging ideas. Such things can only be learned from intelligent thinking and planning about the customer's business, and they will prove to be the most valuable commodity in achieving successful results.

At this point the meeting was thrown open to general questions and discussion. All of the questions were concerned with the comparative advantages and disadvantages of the extension of the materials manufacturer's trade name to the finished product and the comparative benefits of the S. P. I. handbook for retail buyers as opposed to general informative labeling. It was agreed that while informative labeling was definitely a requirement in the industry, the problem of simplifying names and the problem of the different names to be

incorporated should be left up to a committee appointed by the industry itself. It was on this general note of agreement that the symposium closed.

The importance to industry of health and accident prevention plan

F. A. Van Atta, Industrial Hygienist, National Safety Council

Maintaining the employees of a business in a healthy and uninjured condition can save a great deal of time and money. This saving, however, is by no means all pure gain. It requires a lot of hard work and some expense to produce results. If you consider that the components of a properly functioning safety program are equipment, engineering, education and enforcement it is apparent that the other major expense is the wage of the employees of the safety department or other employees while engaged in safety work.

What other firms are doing can be taken as an indication of what should be a desirable action. One firm remarked when the annual expenditure of its safety department first went over $1,000,000 that it was one of the most profitable expenditures ever made by the company and that it should not be reduced in the slightest.

It is a great convenience to talk about accidents in terms of their direct money cost because it is quite easily measured quantitively and there can be but little argument about it when it has been measured that way. Every man in the plant represents a considerable investment of time and effort in training. If his services are lost either temporarily or permanently this training must be repeated with an unnecessary duplication of effort and with the spoiled material and general loss of efficiency in the plant which goes with the breaking in of a green hand.

Variation in setting up a safety program is almost infinite from the large corporation with a safety director, for the safety inspectors, and a whole covey of subordinate employees of the department to the plant where the owner combines in himself all of these duties as well as those of superintendent, foreman, business manager and common laborer on occasion. An adequate and effective organization can be set up in any case provided that the fundamentals are present.

One of the primary requirements is that the active head of the organization, or of the individual plant, must be thoroughly convinced that the elimination of accidents and accidental injuries is both desirable and feasible. The second step in the production of an effective safety program is an appropriate routine for handling safety materials.

In any organization it is the foreman who finally determines the success or failure of any project in his own department. He is responsible for the execution of any recommendation which the committee may develop and he should be represented on the committee either permanently in the smallest plants or in rotation in larger plants. Safety literature does not speak as much about mechanical guarding and the physical conditions of the work place as it did a few years ago because it is taken for granted that the place of work will be made as safe as possible. To make this a justifiable assumption requires just as much work and just as much attention to detail as it ever did. One of the most necessary duties of the safety committee will be the regular and frequent inspection of the workplace for the detection of hazardous conditions, including such factors as mechanical guarding of power transmission equipment at the point of operation, piling and handling of material, condition of fire prevention and fire fighting equipment, and condition of floors, walls, windows and plant yards.

All accidents, no matter how trivial, should be investigated. One of the most serious weaknesses which creeps into a program of investigations is that of considering them "routine." Every case should actually be followed until the underlying cause is determined. It must be remembered that accidents are almost always caused by a combination of circumstances which usually includes both unsafe acts, careless acts and unsafe mechanical conditions. Investigations or inspections are of little value unless they are made a matter of record so that the results can be of use to others than the individuals doing the work and of use to those persons beyond the span of human memory. These should contain all of the essential information and should be as short as possible.

There is a considerable amount of industrial health work which properly falls within the problem of the safety committee — supervision of general plant sanitation, prevention of injuries by dusts, gases or vapors, control of industrial dermatitis. Very many cases of this which never come to the compensation stage and probably never produce any lost-time are an irritation and source of discomfort to those who are afflicted with them. Most of these cases would be completely prevented by the proper personal hygiene. It is obvious that the best way to avoid skin trouble from contact with materials used in the plant is not to come in contact with them. Next best is the thorough removal of the irritant from the skin by means of cleansing agents which are not themselves irritant and by the laundering of clothing sufficiently often so that it does not become saturated with the irritant and keep it in contact with the skin. I do not mean to belittle the use of protective creams or protective clothing which are very useful in these cases but which are a secondary defense.

One of the major factors in the prevention of accidents and injuries is the attitude and actions of the employees. Safety training should be incorporated in job training so that the workers will carry on their work in the safe way which is also almost invariably the efficient way. The number of safety rules should be kept to a minimum, should be strictly necessary and strictly enforced with sufficient sanction to make their infraction a serious matter.

How we can work with Russia

Rear Admiral William H. Standley, Ret., Former Ambassador to Russia

The destiny of both the U. S. S. R. and the United States will be influenced by the progress and success of their industrial effort, and it has been said that the industrial future of the world is encompassed in steel, wood and plastic.

The exploits of the Red Army give ample evidence of the effectiveness of the Russian war production — of the success of the country's scientists and professional men in producing aircraft, tanks and guns, and all the implements of war. But while the Russians have done and are doing much in all these fields, they realize there is still much more to be done.

Because of the ravages of war, Russia needs, and will need for some time, help in tiding her over the conversion period. The Russian people are looking to America for that help. With our war experience and with full time employment, we can supply in one month after adequate reconversion, enough consumers' goods to meet the needs of our people for a year or longer. We should be able to supply Russia at once with consumers' goods — helping her and, at the same time, solving our own unemployment problems.

PLASTICS*
Engineering Section
F. B. STANLEY, Editor

A multi-purpose molding machine

by N. J. RAKAS and W. B. COUSINO**

As the result of work carried on in the engineering laboratories of the Chrysler Corp., an injection and extrusion machine has been developed that offers great possibilities in both the thermosetting and thermoplastic fields

WHEN the relatively new thermoplastics, such as cellulose acetate, began to be used by the industry, they were largely compression molded in much the same way as thermosetting materials except that it was necessary to cool the dies in order to eject the parts in their rigid and intended shapes. As a result, production costs on these newer materials were high, and the use of thermoplastics was accordingly limited.

However, the adaptation of injection molding from the die casting practice shortly followed. This method has extended the commercial uses of thermoplastics by making many new applications possible, due to the speeding up of the molding cycles. In turn, injection of thermoplastics created large demands on the material suppliers who, in view of mass volume production, were able to reduce the cost of their molding powders to the molders—this saving being ultimately passed on to consumers. Thus, it can be seen that thermoplastics benefitted in two ways from the use of injection molding. The thermosetting plastics, on the other hand, still had to rely upon their initial cheaper material price and generally better heat performance to maintain their place.

About the time injection molding became a reality, the development of transfer molding and later jet molding started the early work toward the injection of thermosetting compounds. From the standpoint of automatic fabrication, this latter process simulates injection molding principles more closely than transfer molding.

Another noteworthy method of molding plastics was that of dry extrusion, pioneered by the extruders. The technique of producing tubes, rods, sheets, bars and other cross sections in continuous lengths was a definite contribution to the field of thermoplastics. According to a publication in "British Plastics," thermosetting compounds are now being commercially extruded in England. Prior to the present war, it was rumored that Germany also had extruded thermosetting plastics on a laboratory scale. In the United States the development of extrusion methods provided a means whereby thermoplastics again found newer outlets, this time as extruded parts. In fact, the rapid strides made by thermoplastics were due to a very considerable degree to these new molding techniques.

The Chrysler Corporation, a large user of plastics, pursued an extensive program on the development of injection and extrusion molding. The result of the work carried on in the Engineering Laboratories was the development of an injection and extrusion machine offering great possibilities. It has been thought worthwhile to present, at this time, the chronological development of the Chrysler plastics machine as well as to indicate its possible uses in the field of thermosetting plastics. Promising results have been obtained with injection molding of thermoplastics and more work is being

** Project engineers, Engineering Div., Chrysler Corp.

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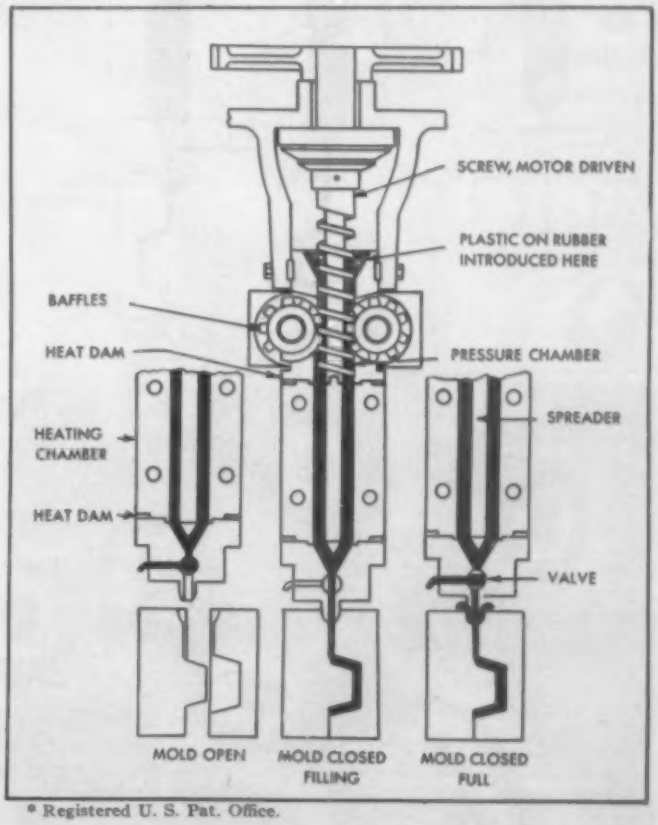

1—*In adapting this machine to the extrusion of thermosetting plastics on a continuous basis, a screw injector driven by an electric motor was substituted for a double plunger. High injection pressures are obtained in this unit by the aid of baffle gears which prevent the molding powders from backing up into the top of the screw. The temperature around these two baffle gears is closely controlled in accordance with the plastic used*

* Registered U. S. Pat. Office.

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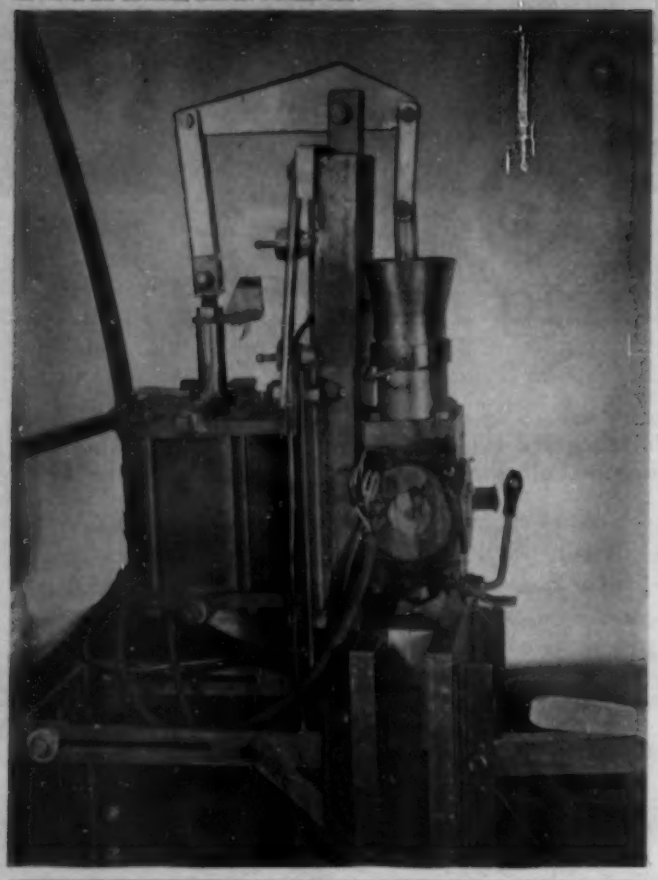

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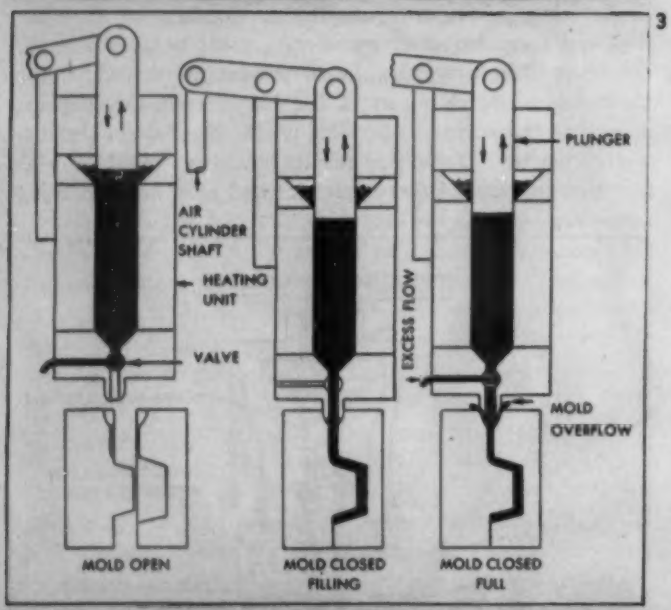

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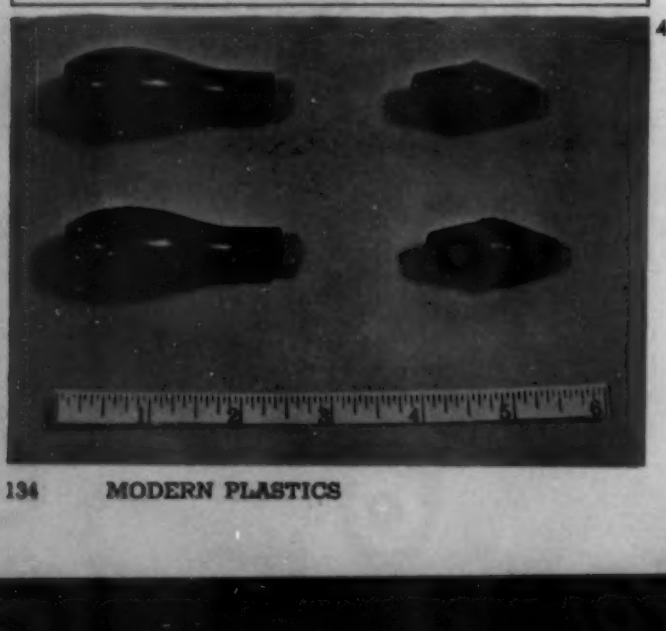

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planned for these materials for future development. To date most of the experimentation has been carried out with the injection and extrusion of thermosetting compounds.

Early development

Walter P. Cousino, project engineer and inventor, a member of the Engineering Division of the Chrysler Corporation, became interested in a plastics machine as the result of a hobby which he conducted in the basement of his home. In order to provide small rubber tires for toy gasoline-operated racing cars for the novelty trade, he devised a method of molding them himself. Mr. Cousino built all the equipment for compression molding these rubber tires and eventually fabricated a volume of 17,000 midget tires per year—all on his own equipment.

Mr. Cousino then became interested in plastics and soon obtained a contract for molding small plastic gasoline tanks for midget airplanes. These were produced with the same rubber molding compression presses he had used in the manufacture of toy car tires. Later, taxidermists and others who wanted to place small orders, heard of his basement molding shop. In attempting to fulfill their demands, Mr. Cousino soon realized that the compression method of molding thermoplastics was too slow. On the other hand, he could not afford to purchase a conventional injection molding press. Thereupon, he proceeded to build his own injection press at a total cost of less than one hundred dollars (Fig. 2).

Invention of single plunger type machine

This original machine utilized the reciprocating plunger principle shown in Fig. 3, and became known as the single plunger type. The thermoplastic powders were loaded into a circular hopper from which the reciprocating plunger fed the plastic granules into a heating unit. In this unit, the material became plasticized under electrical heat. The mold was then closed by a mechanical toggle system manually operated following which the reciprocating plunger was again started to inject the heated plastic into the cavity of the die. (In Mr. Cousino's machine, the plunger was actuated by an air compressor.) As soon as the mold became filled, the excess material backed up as overflow around the nozzle contacting the sprue of the die (Fig. 3).

At this point, a manually-operated valve was closed to prevent excess material from oozing out of the nozzle while the injected shot was cooling in the mold (Fig. 3). After the injection-molded part had become sufficiently cool, the mold was separated by operating the toggle mechanism in reverse and the piece finally ejected by hand.

With this particular setup, Mr. Cousino injection molded

2—The original injection press, which was built at a total cost of less than one hundred dollars, utilized the reciprocating plunger principle. 3—In this machine, which became known as the single plunger type, thermoplastic powders were loaded into a circular hopper from which the reciprocating plunger fed the granules into a heating unit where the material became plasticized. Next the mold was closed; and the plunger was again started to feed the plastic into the cavity of the die. As soon as the mold became filled, the excess material backed up as overflow around the nozzle. At this point a valve was closed to prevent excess material from oozing out of the nozzle. 4—Plastic handles weighing less than one ounce were molded with this set-up

plastic eyes for a taxidermist and plastic handles for an adding machine manufacturer. The handles weigh slightly less than one ounce. The molding cycles were comparable to those obtained in a conventional injection press (Fig. 4).

In cooperation with Chrysler engineers, the following thermoplastics were tried in Mr. Cousino's basement: cellulose acetate, cellulose acetate butyrate, polymethyl methacrylate and polystyrene. The results obtained with these materials were so promising that it was decided to redesign the original model and build it larger.

Second model—double plunger type

The development of this machine was carried out in the Engineering Division of the Chrysler Corporation. Designed by Mr. Cousino and the Chrysler engineers, this machine was equipped with two reciprocating plungers instead of one as in the first model. This second machine was built in the engineering machine shop (Fig. 5).

Following the completion of the machine, an experimental injection molding program was started with various thermoplastics. Samples of parts weighing up to 12 oz. were injection molded with this machine. During the experiments, it was found that the dual plunger machine performed better than the single plunger type. Better welding properties were obtained, enabling us to mold large rings.

Injection of thermosetting plastics

Subsequent to the injection molding of thermoplastics, thermosetting plastics such as phenolics were also tried with this machine. At first, several attempts were made with little success; however, the results obtained were promising. After several experiments during which various temperatures of the nozzle and in the heating chamber were tried, encouraging results were obtained in determining a range of temperatures for successfully molding a macerated paper-base phenolic. There were no particular reasons why this compound was selected in preference to any other, except that we had this material on hand. Parts molded of phenolic paper base are shown in item No. 3, Fig. 6.

Later, when wood-flour-filled phenolics were molded, the machine performed as well as it did with the paper-base stock. The experimental molding cycles varied from 45 sec. to $1^1/_2$ min. for a $^1/_8$-in. crosssection weighing approximately 2 ounces. Satisfactory cures were obtained in one minute. The die temperature was held at 325° F. ± 10°. Samples of parts molded from wood-flour-filled phenolics are shown in item No. 4, Fig. 6.

As the experiments progressed, it was noticed that better results were obtained with thermosetting materials than

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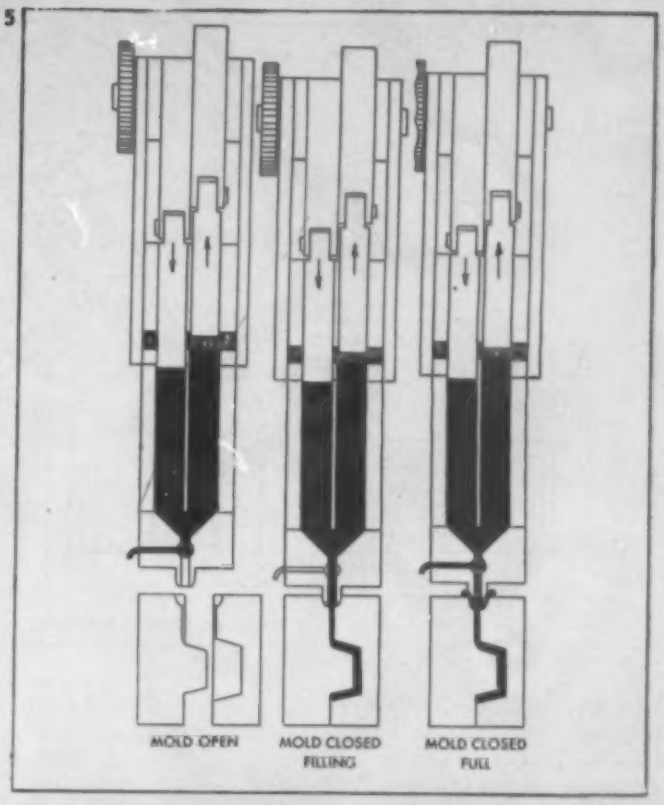

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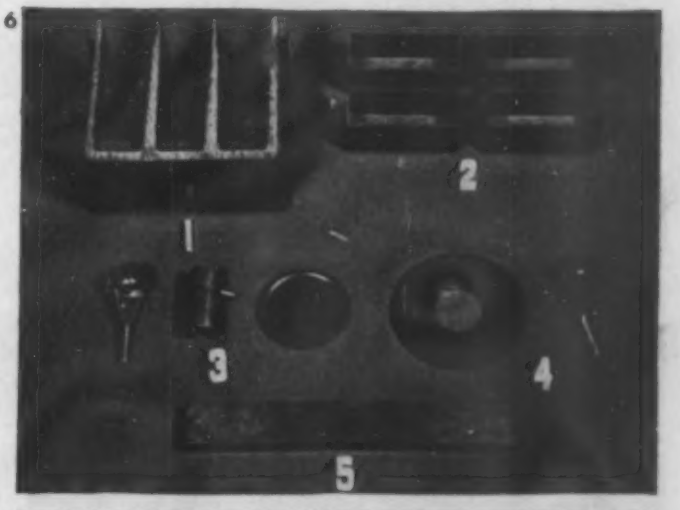

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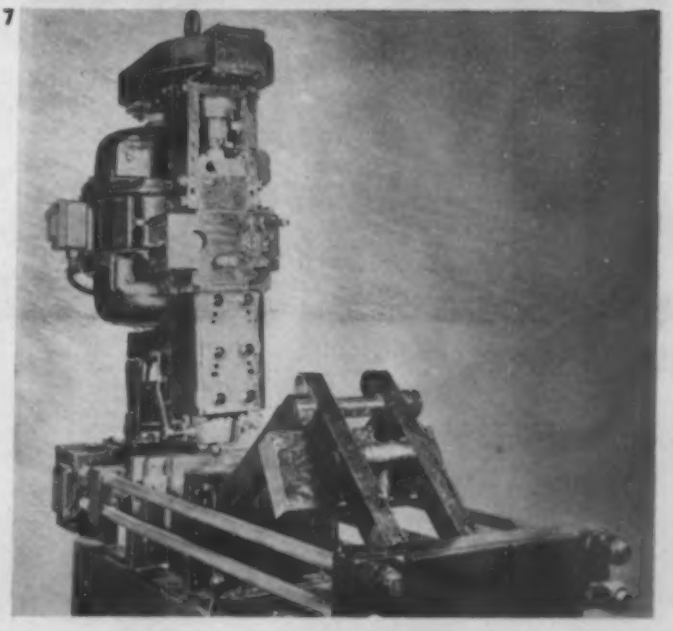
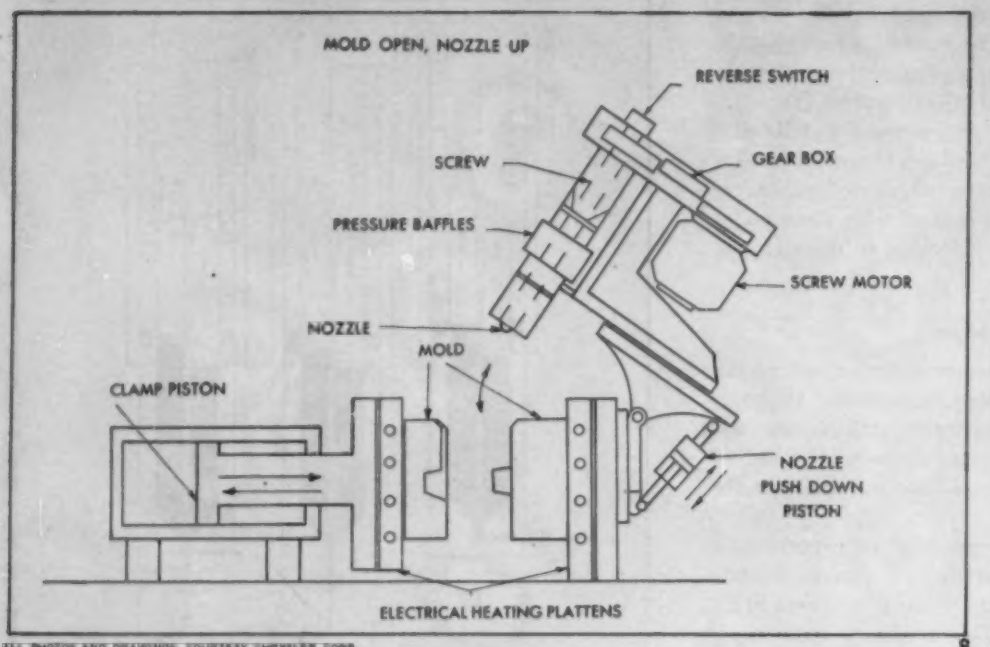


5—The second model of the plastic machine was a redesign of the original press, much enlarged. This unit was equipped with two reciprocating plungers instead of one as in the first model. 6—Thermosetting as well as thermoplastic materials were injection molded in the two-plunger type press. Parts molded of phenolic paper base material are shown in group No. 3; the sample pieces arranged in group No. 4 were molded of wood flour-filled phenolics. 7—Although the double plunger machine gave good results in the injection and extrusion of thermosetting plastics and in the injection of natural and synthetic rubbers, and has shown promise in the injection of thermoplastics, a new press was designed in which a screw injection was used for the double plunger



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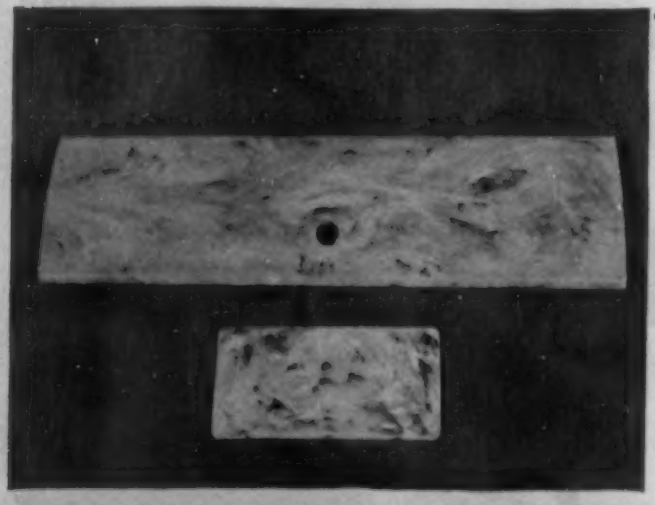
***8**—The Chrysler extrusion head is adapted to the process of continuous transfer molding of thermosetting materials into one or more molds. In this view the head is held in an open position.* **9**—*Mottled thermoplastics can be handled by this screw injection press.* **10**—*When a screw injector was employed, the battery box filled out completely (right). This was not the case when a double plunger injector was used as for the battery box shown at the left of this picture*

with thermoplastics. However, the performance of the machine with thermoplastics is by no means discouraging.

Injection of rubber

Inasmuch as both rubber and plastic applications are developed conjointly in the Chrysler Engineering Rubber-Plastics Laboratory, it is only natural that the machine should have been tried for injecting rubber. Because of the experience gained with thermosetting plastics, we did not have any difficulty in injecting satisfactory rubber parts. The molds used for thermosetting plastics were also used to inject both natural and synthetic rubbers. In view of our success with rubber, and because of the importance that such development might take, the Chrysler engineering management decided to divide the work into two separate projects—one for the injection molding of plastics and the other for the injection molding of rubber.



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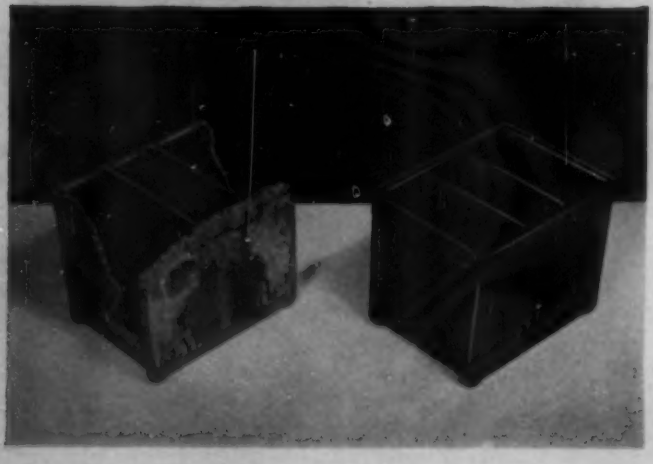

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Extrusion of thermosetting plastics

One day an application in a thermosetting plastic was directed to our attention. The part was about 18 in. long and 2 in. in diameter with a $^1/_8$-in. concentric parallel wall. It was specified that this part should not be laminated, but should be molded from a phenolic powder. After studying this particular application, it was felt that the item in question would be difficult to fabricate as a transfer or compression molded part.

As a result of our previous work with injection of thermosetting plastics, we first thought of molding this part by injection. However, this presented some difficulty in view of the fact that a removable mandrel had to be used in order to enable stripping the molded part while another part was curing in the die. It was then that extruding the part and cutting it in 18-in. lengths was suggested. Extrusion appeared to be possible by mounting an extrusion die against the front end of the injection head. After several unsuccessful experiments, we were finally able to extrude a tube 22 ft. long. *The extrusion of thermosetting plastics on a continuous basis had been achieved.*

Screw injector

Although the double plunger machine had given good results in the injection and extrusion of thermosetting plastics, and in the injection of natural and synthetic rubbers, and had shown promises of success in the injection of thermoplastics, it was considered advisable to make certain modifications in the injection head. Instead of a double plunger, it was decided to substitute a screw injector driven by an electric motor (Fig. 7).

The main advantage of the screw injection was to give continuous injection of the material, regardless of its bulk

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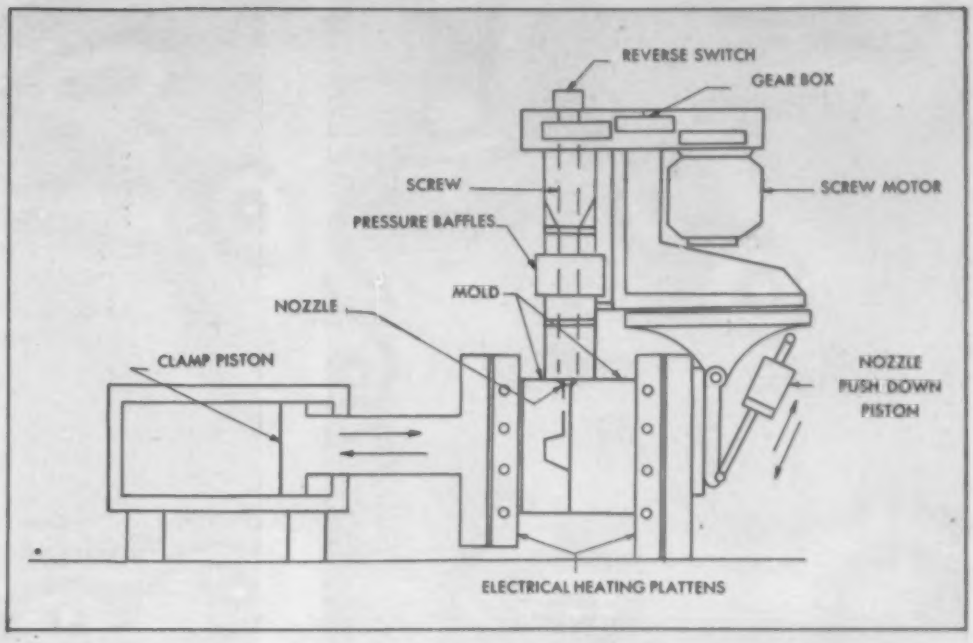

11**—This is another drawing of the unit in Fig. 8 but in reverse or molding position. The push-down piston has lowered the extrusion head, and the nozzle is in position to extrude or transfer the partially polymerized material into the closed mold.* **12** *and* **13—A Chrysler injection head has been installed on this standard injection press which has been converted so that rubber may be molded by this process. A spool of rubber makes continuous feed possible*

factor, until the mold cavities are completely filled. As a result, it appeared possible to inject larger pieces than ever before. Until then, the heaviest parts that could be molded on the Chrysler machine weighed up to 12 ounces. With a screw injection model we felt confident of molding heavier pieces. Experiments were conducted with phenolic battery boxes which, at that moment, were being considered as a possible substitute for boxes made of hard rubber.

We proceeded to mold a battery box using a macerated paper-base phenolic, a material with which we had more experience than with any other molding powder. An obsolete die was secured from one of the battery makers and reworked from a compression die into an injection die. Since the machine did not have enough mold clamp, the battery box was fitted into a steel jacket made of 2 and 4 in. thick steel plates screwed together with high-strength bolts. Knowing the injection pressure developed in the nozzle, it was possible to calculate the necessary mold clamp to retain the battery die within the steel jacket. When the battery die was assembled and placed within the steel jacket box just described, it was placed upon the frame of the injection machine in such a manner that the nozzle could seat properly against the sprue. The steel box and the battery die were heated electrically up to the curing temperature of the paper-base phenolic. Next, the injection head was heated to the proper temperature and the material was fed by the screw from a suitable hopper into the heating chamber of the injection head. As soon as the heat saturated the phenolic molding powder within the heating chamber, the screw was again started and the injection was underway. It took 2 min. to fill the battery box die with 8 lb. of paper-base phenolic. The rate of injection of the 2-in. screw, turning at 128 r.p.m., was consequently 4 lb. of material per minute. On the basis of laboratory results, we believe that in normal production a cycle of 5 min. for molding phenolic battery boxes would be maximum with the possibility of cutting it to 3 minutes. (*Please turn to next page*)

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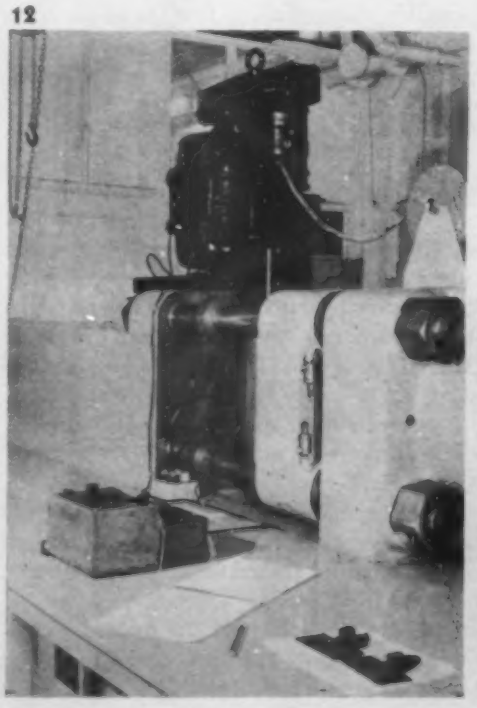

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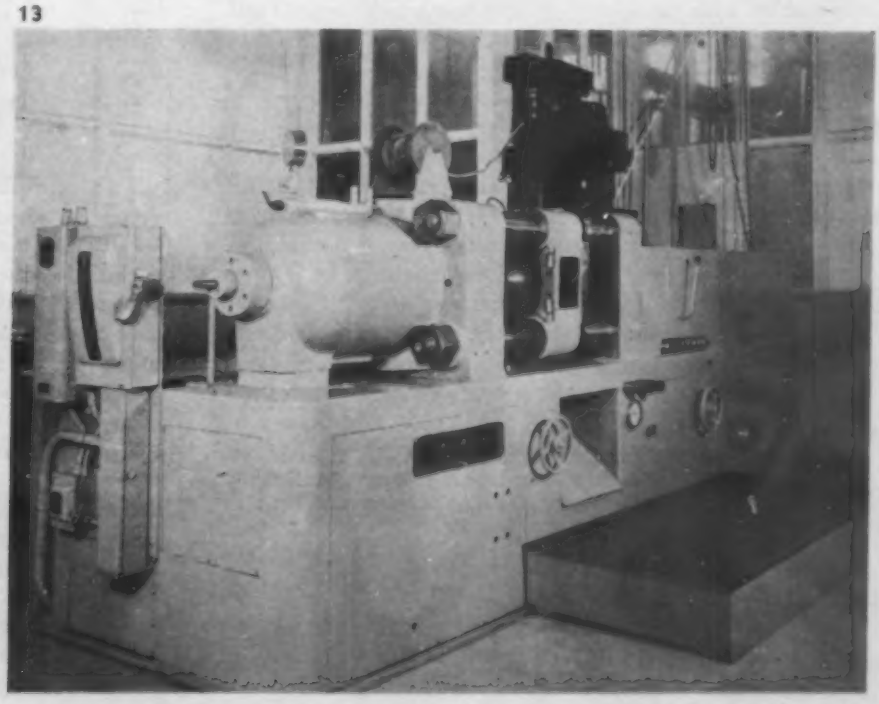

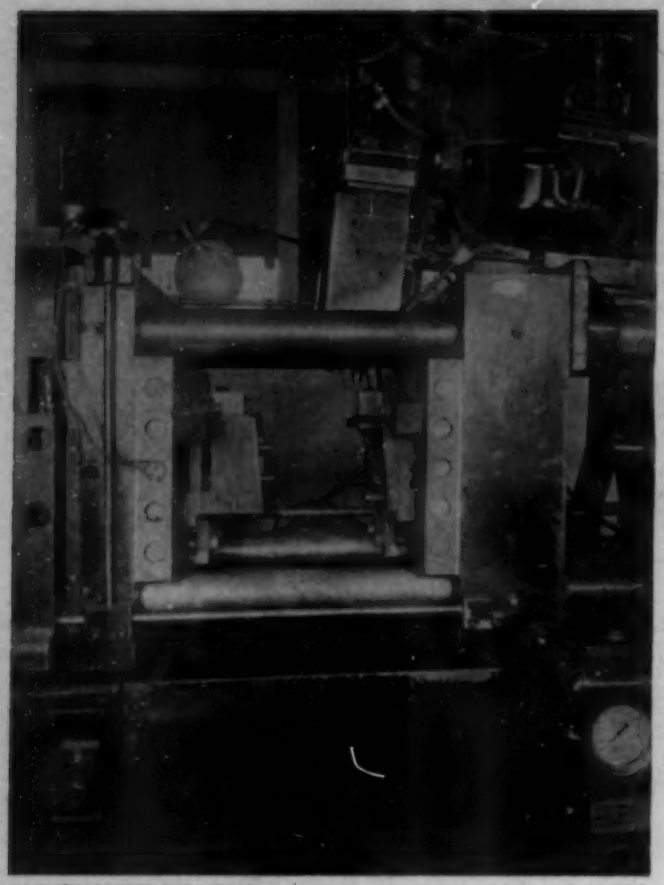

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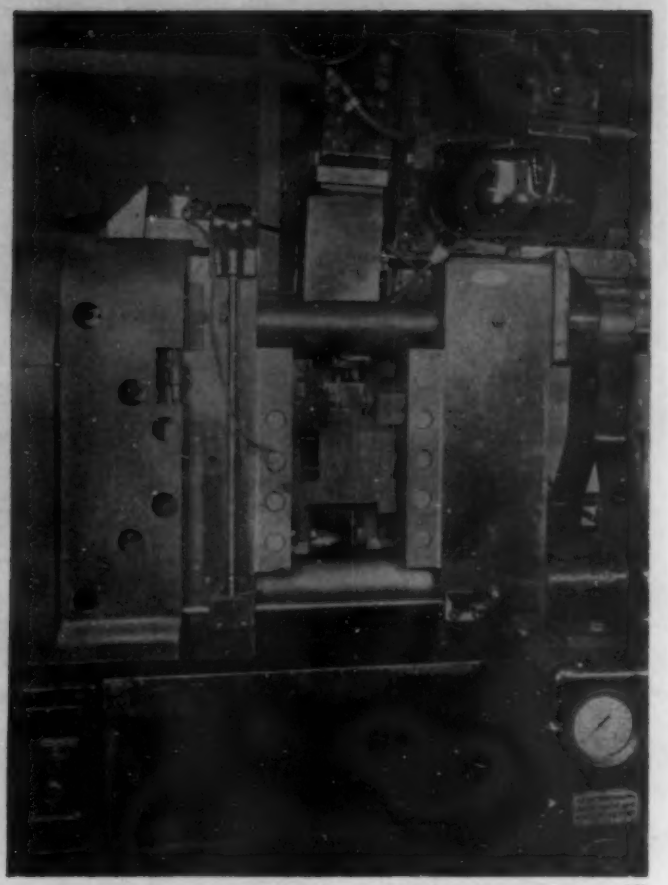

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14—This unit was set up for experimental molding of plastics. In this close-up of the head, the nozzle is in the raised position and the mold is open. 15—Here the mold is closed, and the nozzle and head in a molding position

In order to verify the results obtained with the screw injection machine against that of the double plunger type, molding experiments were conducted with a battery box. The screw injector was removed from the machine and replaced by the double plunger type of injector. Other molding factors, such as molding material, temperatures, etc., remained the same as in the case of screw injector. The battery box molded with the double plunger injector did not fill out completely, indicating thereby that the screw injector was preferable to the double plunger (Fig. 10).

These results were the cause of dropping the plunger type of plastics machine whose main disadvantage was the pulsative injection which at times is apt to show flow marks in the piece. Later, it was found that all other materials, such as rubber and thermoplastics, molded easier and better with the screw injector. Oddly enough, even the mottle-colored thermoplastics can be handled. However, they require a very close balance of temperatures in the injection head. An actual comparison was made by taking one of the prewar mottle plastic parts molded with a conventional injection press and checking it against a part molded with a screw injector using the same molding powder (Fig. 9). There was no difference in appearance as far as the mottle effect was concerned. Originally, there had been some doubt that it might be difficult to handle mottle-colored molding powders; this experiment proved, however, that it would not.

Operation of screw injector

When thermosetting plastics are molded with the Chrysler plastics machine, the injection head is heated to the proper molding temperature within the heating chamber and the nozzle. After the desired injection conditions are obtained, the screw feeding the molding powder from a convenient hopper into the heating chamber is started (Fig. 8). As soon as the heating chamber becomes filled with molding powder from the hopper by virtue of the screw feed, the screw is stopped. It takes from 15 to 20 min. to heat the material sufficiently. After this interval the injection head is lowered down against the clamped die so that the nozzle seats tightly against the concave entrance of the sprue adaptor (Fig. 11). The screw is again started, injecting the heated material by pushing it with cold material from the hopper (Fig. 1). The screw revolves until the cavity of the die is filled.

An electrical switch stops the screw and immediately reverses the screw a fraction of a revolution as soon as the mold is full. The nozzle is held down against the sprue from 10 to 15 sec. after the screw has stopped, and is then raised slightly upward by a tilting device operated hydraulically or by an air cylinder. While the nozzle is held down, a valve is closed to prevent the material in the mold from backing up into the heating chamber when the screw is reversed. Raising the head separates the nozzle from the sprue adaptor; as a result, the material does not precure in the nozzle for the next injection cycle. If the head were permitted to contact the sprue too long, while the material cured in the mold, the heated die (approximately 325° F.) would transfer enough heat into the nozzle, precuring the material and preventing the next molding cycle from getting underway. After the material is cured, the die is opened and the molded part is ejected by a suitable mechanism. The die is closed again and the next cycle started by lowering the head against the die in

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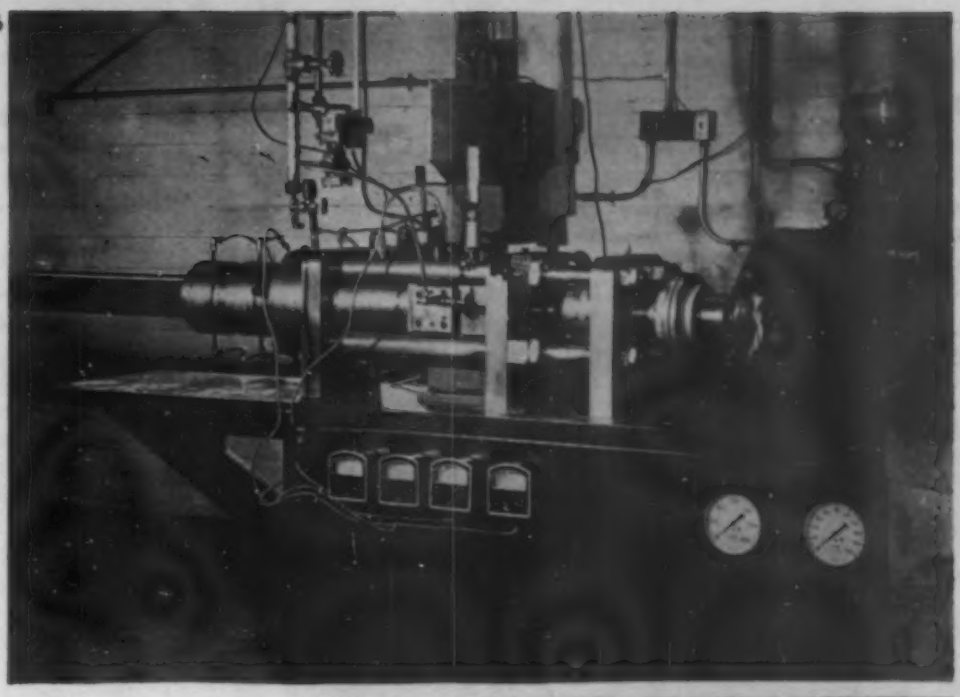

16—Designed on the basic Chrysler principles, this machine has produced 5 in. thermosetting tubing continuously for more than 10 hours. 17—Tubing 5 in. in diameter with a wall thickness of 14 in. has been produced experimentally for launching tubes. 18—The small tubing is 2 in. in diameter with a wall thickness of 1/8 in. It was extruded in a dual plunger machine. The larger 5-in. tubing is the same as shown in Fig. 17

order to completely fill the molding cavities with the screw injector.

The following factors possibly need further explanation. Most of our work has been done with the screw turning at 128 r.p.m., and injection pressures running up to 22,000 p.s.i. The high injection pressures are obtained by the aid of baffle gears (Fig. 1) which prevent the molding powders from backing up into the top of the screw and into the hopper. The temperature around these baffle gears is closely controlled according to the type of plastic being molded and the temperature at which it becomes soft.

Reversing the screw accomplishes two things. First, it makes it possible to start the next injection cycle with less starting torque on the electric motor. Second, by reversing the screw, the pressure on the material in the heating chamber and nozzle head is released, thereby preventing the material from precuring so that it can remain in a softened state for the next injection shot. If the material does precure (which usually is the case with different thermosetting compounds until a molding cycle is worked out) the design of the heating chamber, nozzle and screw is such that the time involved for cleaning out the precured material is reasonably short. Different parts, molded and extruded with the screw injector, were made from thermoplastics, thermosetting compound and rubber.

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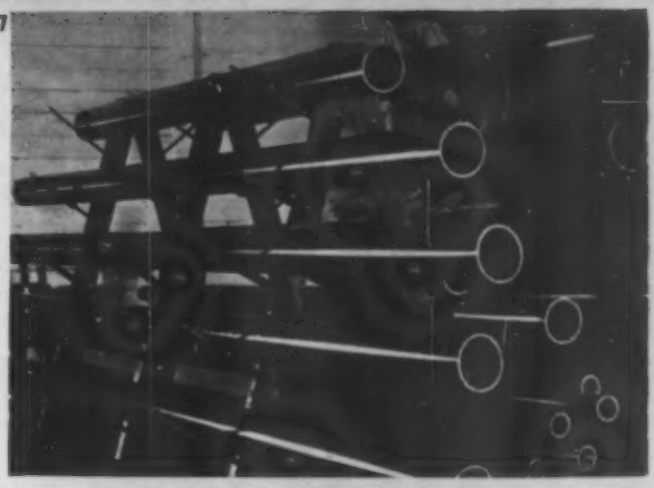

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Recent developments

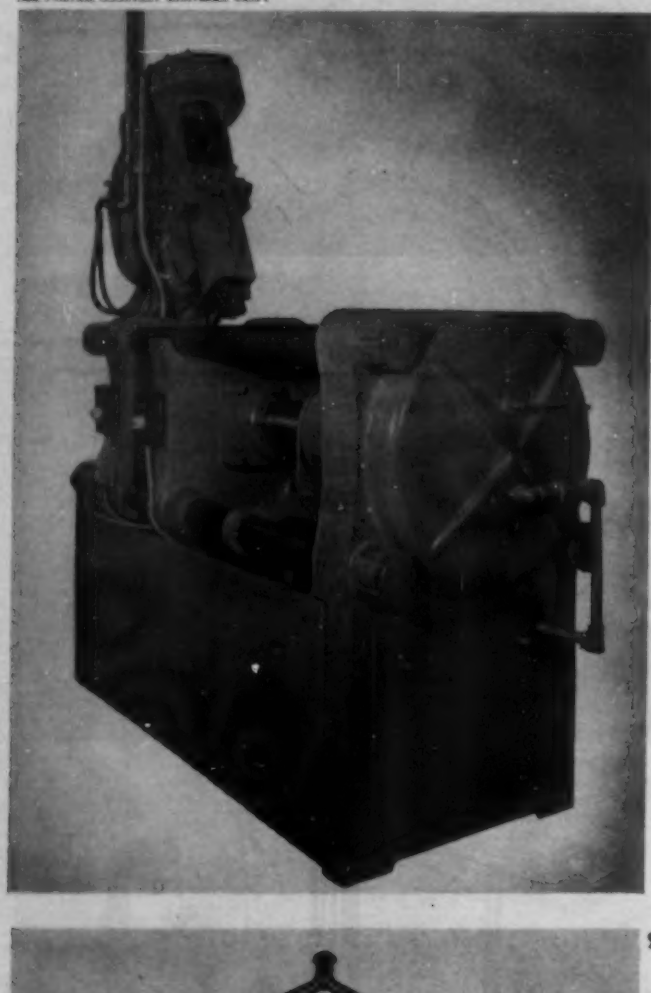
During the early experiments with the injection machine, little attention was paid to either the mold clamp or the frame structure of the machine. As the development of the screw injection machine had progressed sufficiently to enable us to contemplate production of rubber and plastics parts, it became necessary to study the machine from an over-all standpoint. This study was started with two conventional injection presses we had available in the corporation. One Chrysler injection head was adapted to one press for rubber molding (Figs. 12 and 13) while another head was installed on the other press for plastic molding (Figs. 14 and 15). Both machines are at the present used in the further development of the injection head for the molding of rubber and plastics. In the meantime, a complete machine has been designed in-

cluding a mold clamp, injection head, and other necessary parts and switches to make this machine fully automatic.

Proposed future program

In conclusion, most of the results obtained to date have been on a pilot plant scale. It can be seen from the variety of parts that have been injected, plus the fact that the machine is also capable of extruding thermosetting plastics on a continuous basis, that it will only be a matter of time before it can definitely be said that the machine is ready for mass production fabrication of plastics. This has already been done with rubber and it is expected that in the none too distant future it will also be done for the extrusion of thermosetting plastics. A little more refinement is necessary to have this machine ready for injecting thermosetting plastics on a production basis.

ALL PHOTOS, COURTESY CHRYSLER CORP.



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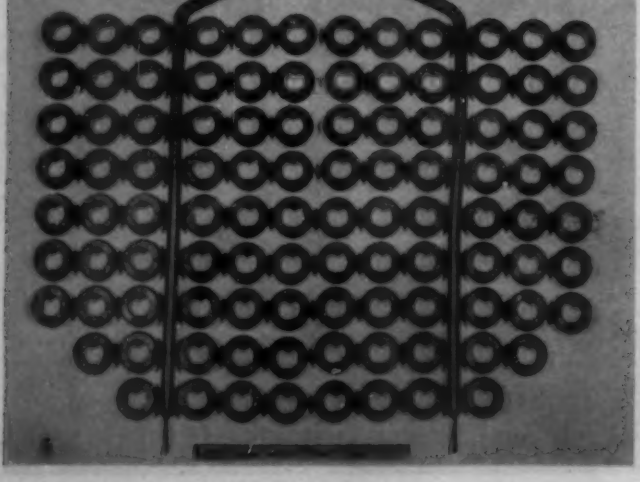

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The machine has been primarily developed to inject large parts. We feel there is a definite need for such equipment if plastics are going to find increased uses, not only in automobiles but in other fields as well. As previously mentioned, our best attempt to date has been the injection molding of battery boxes weighing 8 pounds. On the basis of this result, we can foresee injecting even larger parts providing the mold clamp is sufficiently high.

The development of the Chrysler plastics machine has so far been carried out with only a few plastic molding powders. This was purposely done to minimize outside factors, since one material differs to some extent from another along the lines of softening points, flow and thermal conductivity. Now, since most of the important characteristics of the machine have been determined, such as temperature control within the injection head and nozzle, rate of feeding the material into the machine from the hopper, and the amount of injection pressure, the problem becomes simplified in order to mold different grades of thermosetting compounds as well as thermoplastics. In view of these facts, a program has been arranged, whereby a number of molding powders available on a large volume basis will be tried in the Chrysler machine in the Engineering Rubber-Plastics Laboratory. A new injection head, with latest revisions over and above the present screw injector, is now being made in order to carry out the proposed program.

Present licensees

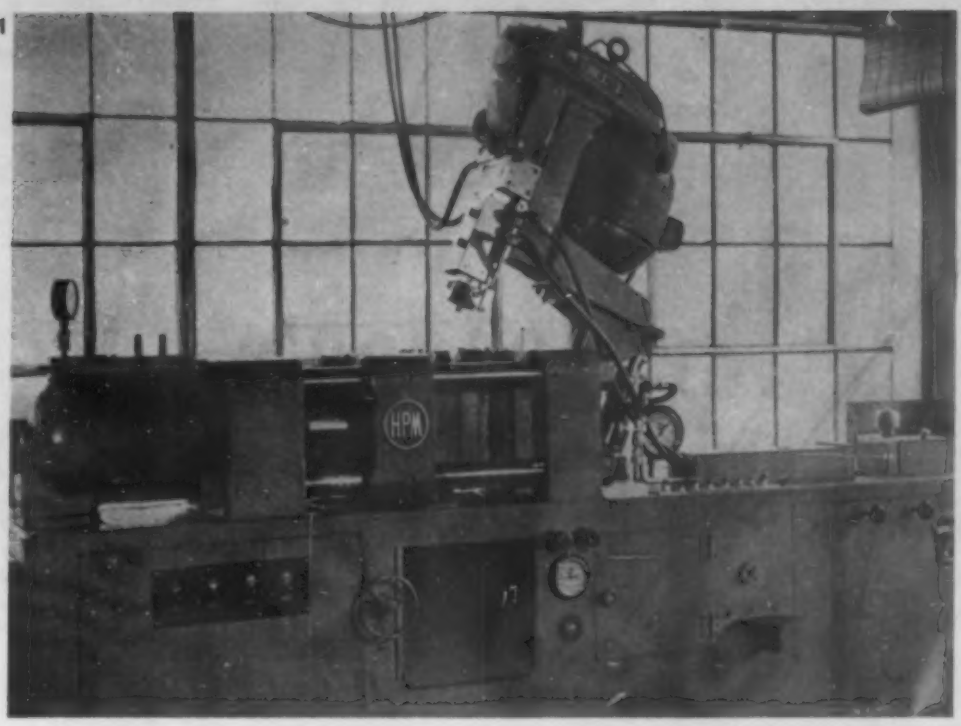
The Chrysler plastics machine has created such an interest in the plastics and rubber industry that a number of firms have requested licenses to build and operate a machine of this type. Among the firms interested in the Chrysler plastics machine, the Plastics Engineering Inc., requested a license to build a machine for extrusion of thermosetting plastics in connection with a highly important experimental program. This license was granted and an extrusion machine was built based on our latest design for the screw injection head, together with other extrusion data we had on hand. The actual setup is shown in Fig. 16.

The plastic powder is dumped into a hopper where the screw receives it horizontally and feeds it through the heating chamber with the aid of two baffle gears similarly used for injection of plastics. The plasticized material is forced through an extrusion die which gives the plastic its exact extruded shape. The thermosetting compounds actually cure as they travel through the die so that curing is completed when the part leaves the outlet end of the die. Finally, the extruded cross-sectional shape is cut into specified lengths. Representatives of this company, with the cooperation of Chrysler engineers, spent a great deal of time and effort in working out the final details of the extrusion die structure. All their extrusion was done on a pilot plant setup. A few samples of the extruded lengths of pipe can be seen in Fig. 17.

Pipes with diameters $1^{7}/_{8}$, 3 and 5 in. O.D. and approximately $^{1}/_{4}$-in. wall thickness have been extruded on a con-

19—Another injection molding machine, built by a second licensee, injects rubber on a production basis. 20—These small Neoprene bushings were molded in a 102-cavity die in a $3^{1}/_{2}$ min. cycle. If they had been molded by compression, the cycle would have been 30 minutes

21



21—An injection head, constructed on the basis of the Chrysler design, was installed on this standard 4-oz. injection molding press. **22**—*A 4-cavity die was built for experimental work with the machine shown in Fig. 21. The boxes produced in this mold are 5 1/2 in. long, 2 1/8 in. wide and 2 1/8 in. deep with a wall thickness of 0.090 inch.* **23**—*Gating for these boxes is evident in this illustration*

tinuous basis, in varying lengths, from a macerated paper-base phenolic. Some extrusion has also been done with wood-flour-filled phenolic. It is planned to try other types of thermosetting plastics such as melamines, ureas, and other filled phenolic compounds.

With the present pilot setup the company has been able to extrude at rates of from 10 to 60 lb. of plastic per hour. The screw speeds vary from 10 to 100 r.p.m. Production rates and screw speeds both depend upon the material and the size and shape of the part. At present, the Plastics Engineering Inc., has standardized on a 2-in. diameter worm screw, although future development might change this picture. A different die is, of course, required for each different size or shape being extruded.

The young lady in Fig. 18 is holding a 2-in. diameter pipe with an 1/8-in. wall thickness. This pipe was extruded about two years ago at Chrysler using the dual plunger machine. The larger pipe is 5 in. in diameter, and was extruded by the pilot plant mentioned above, using the screw-type machine. The screw machine has now become standard with this company for extrusion of thermosetting plastics, because of the superior results obtained. Not only is the operation continuous, but the resulting product has improved characteristics, such as greater uniformity of appearance and properties, less porosity and a complete lack of any of the objectional evidences of pulsation.

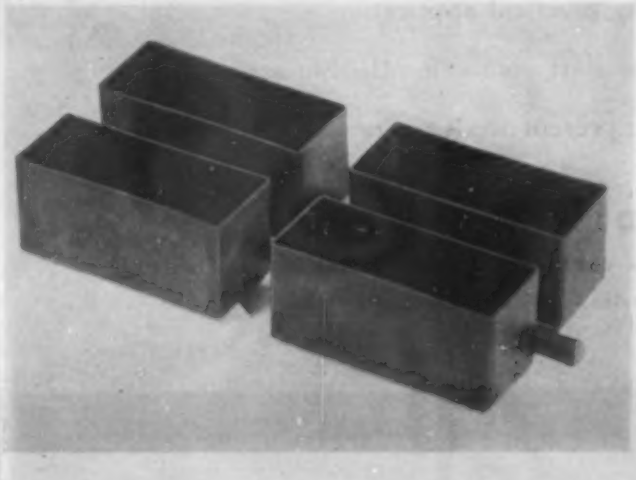
Based on present over-all results of this experimental setup, it is believed that continuous commercial extrusion of thermosetting plastics by this company is not in the too distant future. A few final refinements are necessary on the machine, but it is only a matter of time before these can be incorporated.

As the result of our success in injecting rubber, the Monroe Auto Equipment Co. became interested in the Chrysler machine and built a complete machine designed by us (Fig. 19). With their setup, Monroe Auto Equipment Co. is injecting rubber on a production basis. They have been using a 102-cavity die for molding a small Neoprene bushing (Fig. 20). A 3 1/2-min. molding cycle is required for injecting and curing the Neoprene, whereas, by compression molding the cycle would be about 30 minutes.

The development of rubber injection molding is covered by a paper given jointly by Chrysler and the Monroe Auto Equipment on November 17 in Chicago, Ill., at the meeting of the Chicago Rubber Group, Rubber Division of the American Chemical Society.

The Hydraulic Press Manufacturing Co. has been building hydraulic presses and hydraulically operated machinery for the past 67 years. Compression (*Please turn to page 196*)

22



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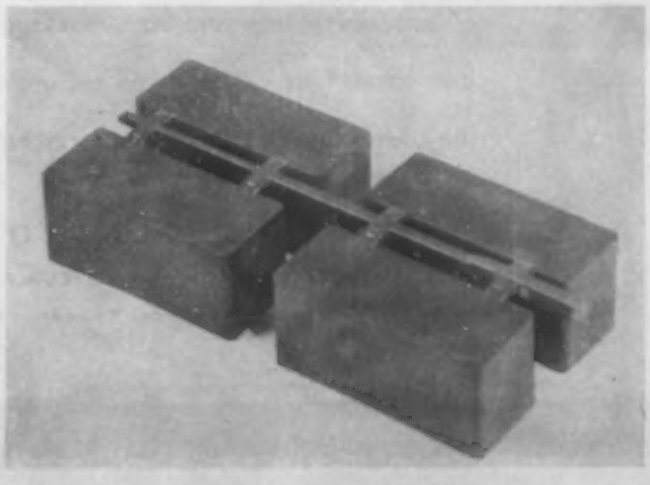

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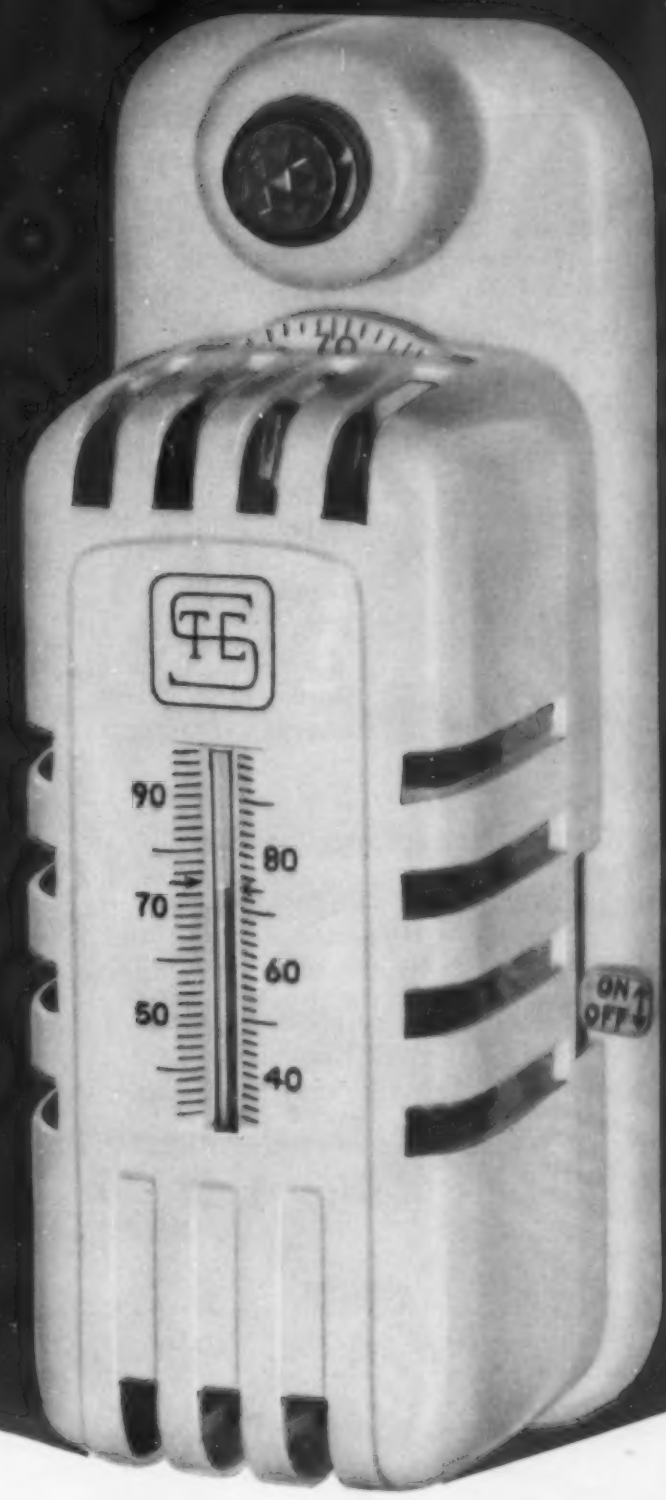

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MOLDED COLOR

Advantages of hard chromium plating on molds and machine parts

by WARREN SCHMIDT*

HOW can hard chromium plating help in the manufacture of plastics? What are the advantages to be derived from chromium plating on molds and dies, and on machine parts such as hydraulic press rams and pumps? The answers given in this article, derived from a visit to a typical plastics plant, might be summarized in the statement of the superintendent that chromium plating of cavities and forces increases the life of the molds by at least 100 percent by increasing their resistance to abrasion and sticking. To this end, plant practice is to strip the cavities of chromium when they become worn and replate.

Hardness of chromium plate

In the plant under consideration, most plastics molds are made of pack-hardened steel. This material is used because tool steel has a greater tendency to crack under the changing temperatures to which a plastics mold is subjected. The chromium plating of a mold to a thickness of 0.0001 to 0.0003 in. represents a comparatively economical and precise method of applying a hard surface to a steel mold. Ordinarily, 0.001 in. is the thickness of plate that can be applied per hour. Chromium provides the hardness that is needed if a mold is to resist satisfactorily the abrasive action of the plastic's ingredients. It is next to a diamond in hardness with a scratch hardness of 2000. Its Moh's scale reading is 9 compared to 10 for a diamond and 7.5 for tungsten. The Rockwell hardness of chromium is 65 to 70 Rc whereas hardened tool steels usually register 63 to 65 Rc. Furthermore, chromium has a Brinell hardness of approximately 1000. It must be remembered, however, that chromium can be plated to varying degrees of hardness.

It is common practice to strip chromium from a worn mold and replate. When molds are made of tool steel hardened to 63 to 65 Rc, it is best, before applying chromium, to draw the steel at 600° F. for half an hour to bring them to 58 or 60 Rc. This is because the plating process will increase the size of cracks in the metal. For the same reason it is also advisable to check worn molds for cracks or flaws before plating.

Effect of plating on appearance of molds

Closely allied with the hard facing that results from the chromium plating of a mold is the improved appearance of the product being processed. Because of the super hardness of chromium, scratches, nicks and scores that are present in ordinary steel molds are noticeably absent on a chromium-plated steel surface. It is true that it is possible to nick chromium-plated steel with a sharp instrument if considerable force is used. However, if ordinary care is taken, this does not occur. Even if a chance blow should mark the chromium surface it is possible to repair it with an India stone or any good grade aluminum oxide composition stone.

A further advantage of chromium plating is that it will wear off gradually without chipping. This characteristic is of particular value on production runs that must be completed on time regardless of the condition of the mold. It is also possible with chromium-plated molds to obtain exceedingly fine and detailed designs especially when a high polish is used.

Increase in production and reduction in losses

It is common knowledge among plastics manufacturers that both pack-hardened and tool steels tarnish when subjected to heat. A badly tarnished mold accelerates the sticking action of plastic, especially when there is a trace of acid in the material. Here again chromium plating of the mold facilitates operations by preventing the formation of tarnish and the consequent sticking of the plastic to the mold. Sticking causes spoilage and damage to the mold surfaces that often occurs when the stuck piece or pieces are pried out of the mold. The reason why chromium eliminates this trouble lies in the fact that the softening point of chromium is 2300 to 2600° F., more than 25 percent higher than iron. Chromium is comparatively close to copper in thermal conductivity and practically the same as iron in thermal expansion. It is probable that these same properties are responsible for the fact that the chromed surface on the heated steel molds does not crack.

Where molds, dies, mandrels, etc., come in contact with glues, cements, resins, etc.—especially when they are oven dried or baked—the sticking of these materials to the ferrous metals is frequently a real problem. The chromium plating of these parts will not only add to their life but eliminate the troublesome sticking. The reason is that apparently nothing will adhere to chromium—including, in addition to the materials mentioned, water, oils, paints, molten metals, acids, salts, alkalines, etc. In a recent instance, an important war contract was held up because a pull of more than 500 lb. was required to remove a cemented paper tube from an 11-ft. mandrel. In the baking operation, the cement adhered to the cast iron mandrel. After the chromium plating of these mandrels, the tubes were removed with a 50-lb. pull, with no tearing of the paper. The fact that chromium is a corrosion-resistant metal protects plated parts during the periods when they are not in use.

Use in rubber and synthetic rubber processing

It can be anticipated that chromium plating will be applied in an ever-increasing extent to parts of tubing machines that are used in the manufacture of such products as insulated wire and rubber hose. Chromium plating is ideal on tubing heads, dies and worm screws where the material, due to curing of the rubber or the plasticity of the material, tends to stick to steel. By eliminating sticking the chromium plating also does away with subsequent losses in labor, material and machine down-time. Mill rolls and mixer parts are other possible applications of this plating.

Machine parts wear longer when plated

An outstanding example of the proper use of chromium plating on machine parts was observed recently in a plastics plant. Excessive machine down-time was recorded at one time in the hydraulic press department. The chief cause of

* Professional industrial engineer.

press down-time was traced to the failure of the pump packing on the hydraulic pumps feeding the molding presses. These pumps have a high- and low-pressure side. The average normal life of a pump packing was 6 weeks on the high-pressure side and 16 weeks on the low-pressure side. The pressure on the high-pressure side was 3300 p.s.i. To overcome the difficulty a battery of these pump rams were chromium plated over 6 years ago. Today only a small percentage show wear—indicating that these few should be stripped and plated again. These particular rams are about 4 in. in diameter and 48 in. long. The phenomenal result obtained by this procedure is indicated by the fact that ever since plating, the high-pressure side has averaged 15 months between packings, and the low-pressure side 26 months. In other words, since chromium plating, the pump packing now lasts 10 times longer on the high-pressure side and 9 times longer on the low-pressure side. This improvement is important in that plating not only practically eliminated hydraulic molding press down-time but also reduced the material cost of the packing and the wear on the hydraulic rams, and accomplished a saving in labor. The average cost of the packing is $14 on both the low- and high-pressure sides—a total of $28 in material cost. The labor cost averages $8 per pump. Thus the total material and labor cost reduction is $36 per pump.

Care must be taken on this type of packing gland not to set the gland box nuts too tight on a new pack. The pack will leak water from 6 to 8 hr. while the gland box nuts are gradually being taken up. Chromium plating the hydraulic rams also creates less friction loss between the ram itself and the packing. As a result, the strokes of the pumps are increased from 42 to 53 per min.—an average increase of over 25 percent more strokes per minute. Feed-water pump rams with a protective chromium plating which operate at 210° F. also functioned satisfactorily over a longer period of time than they had formerly.

Row upon row of chromium-plated hydraulic molding press rams, about 14 in. in diameter and 30 in. long, were operating to satisfaction over a period of years. Incidentally, some of these rams were copper plated under the chromium in order to build up badly scored rams. Due to the inherent softness of the copper, however, chromium applied directly to the steel is a superior application.

Cutting tools useful

Chromium-plated cutting tools have already demonstrated their usefulness in machining (*Please turn to page 196*)

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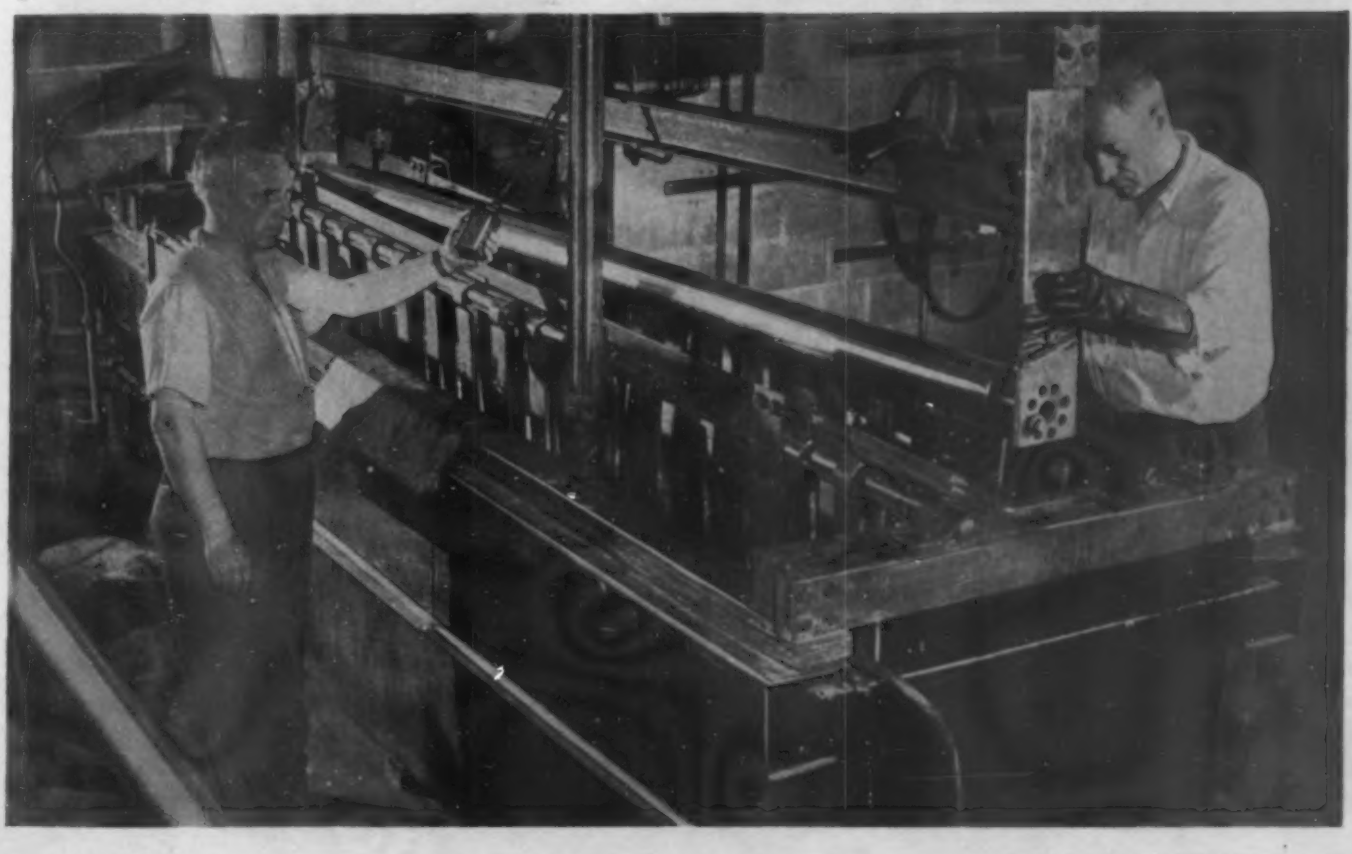
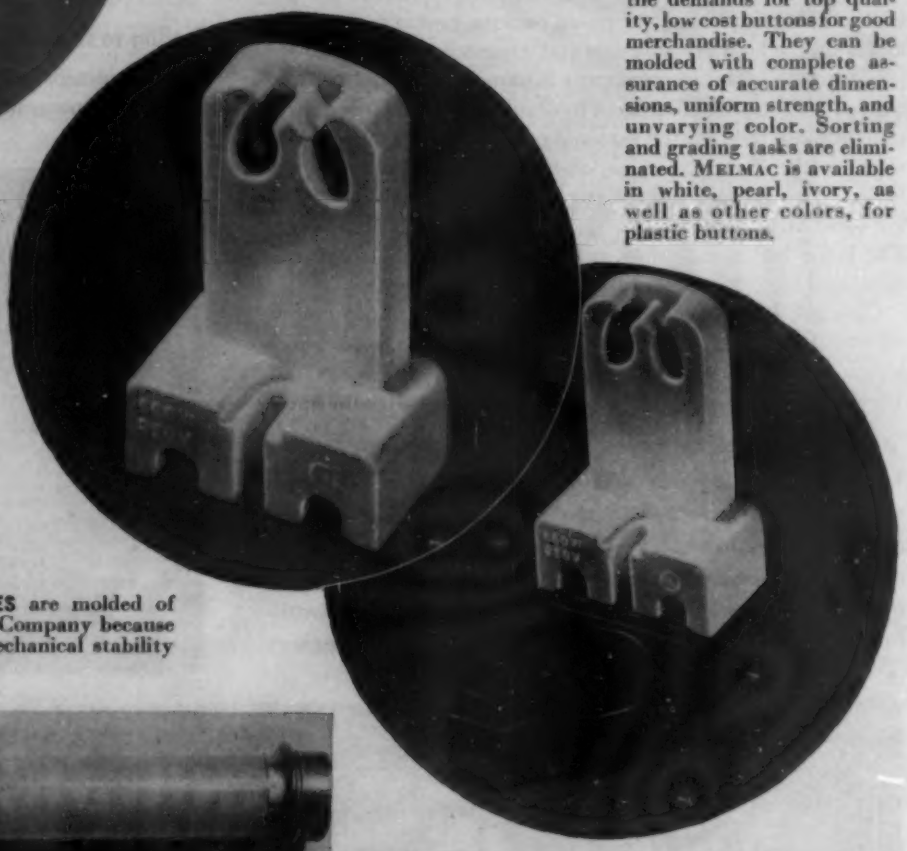


1—Chrome plating this plastics mold provides the hardness necessary to resist the abrasive action of the plastic's ingredients. 2—Operators are shown preparing a cast iron mandrel, used in the manufacture of cemented paper tubing, for chrome plating. This process facilitates removal of the tubing for subsequent processing

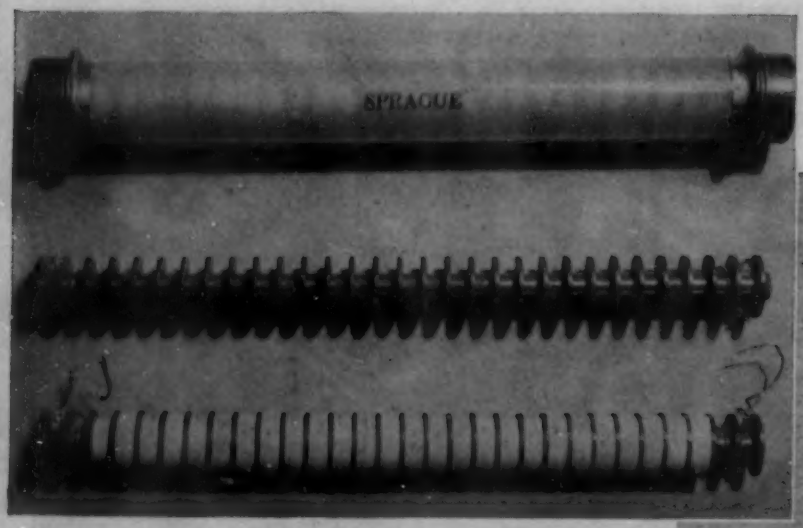
Life ON THE PLASTICS NEWSFRONT

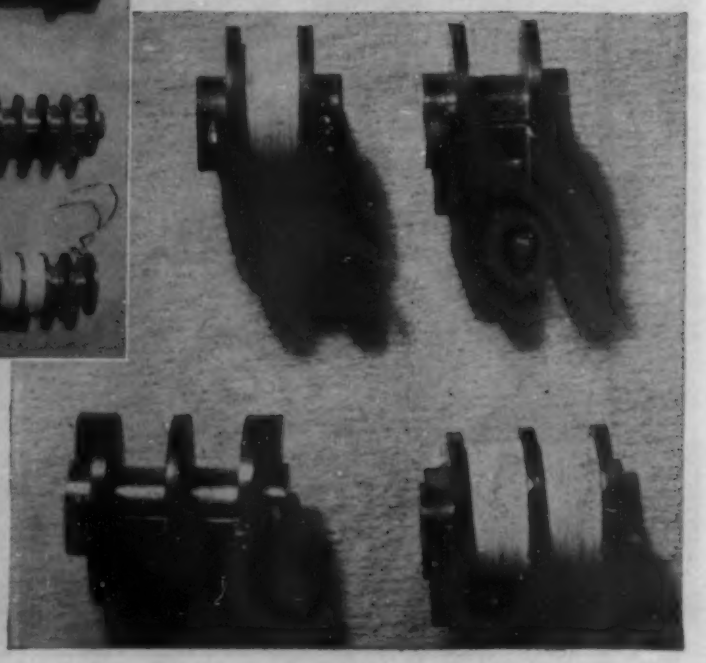
(*Above*) **MELMAC BUTTONS** meet the demands for top quality, low cost buttons for good merchandise. They can be molded with complete assurance of accurate dimensions, uniform strength, and unvarying color. Sorting and grading tasks are eliminated. MELMAC is available in white, pearl, ivory, as well as other colors, for plastic buttons.



(*Right*) **KULKA TURN-TYPE FLUORESCENT SOCKETS** are molded of BEETLE* by Waterbury Companies, Inc., for the Kulka Electric Mfg. Co., Inc., to assure perfect operation mechanically and electrically. These units have a Spring-Hinge Lock to fasten the tube securely in position. They provide perfect contact and are vibration proof. BEETLE's usefulness for electrical wiring devices results from its dimensional stability, strength, its electrical insulating properties, its light weight, and its color.

(*Below*) **WIRE-WOUND KOOLOHM RESISTOR CORES** are molded of MELMAC* S-6003 for the Sprague Specialties Company because of MELMAC's high dielectric strength and mechanical stability at high operating temperatures.





In these applications, and in a multitude of others throughout the industrial field, Cyanamid plastics have proved practical, efficient, and economical. Constant research and development work is carried on to broaden the usefulness and value of plastics in new applications. We will be glad to consult with you on how a Cyanamid plastic can meet your requirements for present or postwar products.

(*Above*) **LISTERINE'S NEW VICTORY TOOTHPOWDER PACKAGE** is topped off with shoulder and cap of eye-catching, bright red BEETLE, molded by Pro-phy-lac-tic Brush Company, Division of Lambert Pharmacal Company.

(*Above*) **A NEW THERMAL TYPE AIR CIRCUIT BREAKER** is molded of MELMAC P-3020 by Kuhn & Jacob and General Electric Company for the I-T-E Circuit Breaker Company since it has the requisite flame and arc resistance, dielectric strength, and heat resistance.

(*Above*) **PLASTIC PILL VIALS WITH COLORFUL BEETLE CAPS** are molded by the Wheeling Stamping Company to meet low cost mass-packaging needs.

(*Above*) **STURDY, SANITARY TOPS** for thermostatically controlled hot food containers, supplied the Army Air Corps by The Tappan Stove Company, are molded of moisture and stain-resistant alpha-cellulose-filled MELMAC by The Watertown Manufacturing Company. *Reg. U. S. Pat. Off.

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Streamlined eye section for B-29

by FRED L. WILLIAMSON*

1

2

ALL PHOTOS, COURTESY BELL AIRCRAFT CORP. 3

1—A finished "eye" section on a B-29 is shown in the inspection booth. Excellent optical qualities are made possible by stretch-forming during which the male form is maintained in a state of constant vibration. 2—The heated material—pliant as a pancake—is handled with gloves as it is transferred from the oven to a forming machine. 3—When the bubble is blown to maximum height, it is held in that form until the material hardens and cools. This is an important operation which requires both good judgment and accurate timing

THE streamlined "eye" sections now being formed by special processes for the B-29 Superfortress not only have an interesting history but plainly refute a recent statement in a nationally syndicated newspaper article that windshields made from transparent plastics distort vision badly—in a manner similar to poor-quality window glass. Before final acceptance by the Army Air Forces, these eye sections must undergo extremely rigid inspections.

Bell Aircraft Corp. originally set up a forming and fabricating department for transparent plastics in 1940. Because of quick changes and new designs it was found more convenient to form these cabin enclosures in the company's own plant than to have them made by a subcontractor several hundred miles away—a procedure that might delay the program.

At the time this new department was opened, most of the forming of methyl-methacrylate sheetings was accomplished by the stretch method. Stretching a sheet of hot plastic over a male form covered with soft cotton cloth gave a fine duplication of contour lines, but great care was necessary in temperature control to keep "mark off"—development of surface defects—to a minimum. In slight draws this was no problem, but as the stretch increased, so did the cloth impressions. Therefore, improved methods for deep draws became a necessity.

One method used to bring about this improvement was to design all-female tools and vacuum the plastic into the mold opening—allowing the sheet to form in along the walls of the form. This process does not have a tendency to put all the load in the high area as is the case when a male form is used, and it lessens the chances of distortion. While there are some mold marks on this type of forming, the process does give the desired lines. *(Please turn to page 200)*

* Assistant superintendent, Plastic Forming and Experimental Dept., Bell Aircraft Corp

In washrooms on warships

Tenite tumbler holders and soap dishes molded by E. B. Kingman Company. Mirror frames extruded by National Plastic Products Company.

MANY new vessels of the world's largest navy are equipped with mirror frames, soap dishes, and tumbler holders of ivory Tenite. These washroom fixtures have the advantage over metal ones of being non-tarnishing and easy to keep clean.

Tenite has good dimensional stability and excellent molding properties. Tumbler holders and soap dishes are produced by the rapid injection-molding process in single cavity dies, with cycles ranging from twenty seconds for a tumbler holder to forty seconds for a large soap dish. Mirror frames are made of continuously extruded strips of Tenite cemented together in a bond as permanent as the material itself.

Tenite may be made in any color to harmonize with individual color schemes, and it will be a postwar material for bathroom fixtures—such as faucet handles, shower nozzles, soap dispensers, drain stoppers, shower curtain hooks. For information about Tenite and its adaptability to your peacetime products, write to

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Lacey-Webber Company, of Kalamazoo, Mich., use 2" O.D. TULOX TT tubing as a replacement for glass in their nationally known "Freezgide". They find TULOX lighter, stronger and—for their purposes—*better.*

Just as an already imposing and still growing list of industries are finding TULOX not merely a wartime replacement—but a postwar *basic material.*

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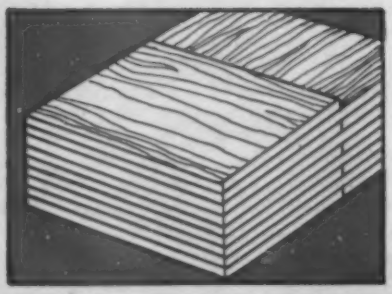
PREGWOOD is a relatively new material possessing many unusual qualities that have adapted it to many uses—such as switch gear in heavy duty switches, picker sticks on textile looms, ski bottoms on military skis.

The test figures shown below indicate the remarkable strength of the material—which has a lower specific gravity than aluminum.

Pregwood has a certain measure of efficiency as an electrical insulator. It is non-absorbent and does not take up moisture. It is chemically inert and can be used for apparatus parts that will be exposed to acids and alkalies.

Changes in humidity have relatively little effect on dimensions; and a low co-efficient of thermal expansion holds the material stable under marked changes in temperature.

It has the quality of wearing smoothly without slivering or cracking. This makes it especially desirable for parts of textile machinery where it will not snag threads of fabrics.



Pregwood is built up by impregnating wood lamina-tions with phenolic resins and pressing them together under heat and pressure. The laminations may be arranged with grain running one direction. This method produces high strength products such as Pregwood 1100.

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#/sq. in. 30,000	#/sq. in. 20,000	Ft. Lbs./In. Notch Width
		Flatwise 7.0 / Edgewise 6.0

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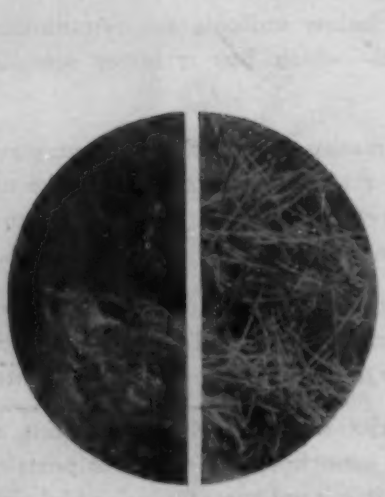

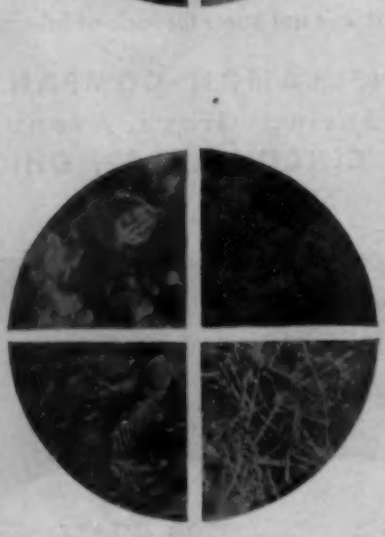

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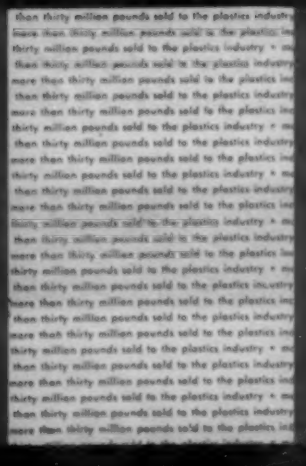
than thirty million pounds sold to the plastics industry
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TECHNICAL SECTION

DR. GORDON M. KLINE, Technical Editor

Creep characteristics of plastics*

by WILLIAM N. FINDLEY**

CREEP of a material is defined as a continuing deformation (change in shape) under a constant stress. The total deformation (here called total creep) after any given time usually includes some elastic and some plastic deformation, and is expressed either in percent or in inches per inch. A great deal of testing to determine the creep properties of metals has been carried out during the past 20 years. (1, 2, 3, 4).[1]

Since the creep properties of plastics are affected by small changes in temperature and humidity, these factors as well as the distribution and state of stress must be controlled. Some creep test data are available for plastics (5–17), but most of these data were obtained for only one temperature and humidity and for uni-axial uniform stress. Further work on creep of plastics under various conditions of temperature and humidity and under various conditions of loading are greatly needed.

For creep tests, especially at relatively low stresses, the instruments for measuring the continuing deformation over long periods of time must have a high magnification. Two types of high-magnification strain-measuring instruments have been used. The first type is the combination mechanical-optical instrument which often consists of a multiplying-lever system combined with a microscope or an optical lever (Figs. 1 and 2). The second type is an electrical instrument, such as the resistance-strip strain gage. This type of instrument, however, would not seem to be well suited to the measurement of creep inasmuch as the strip or wire attached to the specimen and the accompanying cementing material are subject to change resulting from the creep to which they may be subjected. Also gradual changes in the electrical measuring circuit used with the gages may take place over long periods of time. Special care must therefore be exercised in using this type of instrument. Some of the difficulties involved in

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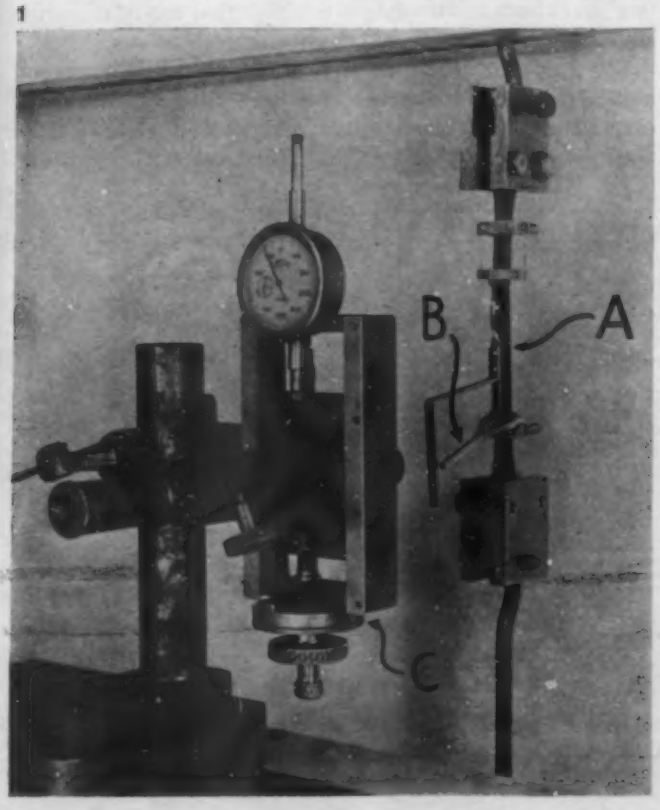
[1] Numbers in parentheses refer to the references at the end of the paper.

1—This high magnification extensometer is used for testing the tension creep of laminates. 2—Apparatus for use in tension creep tests of cellulose acetate

1



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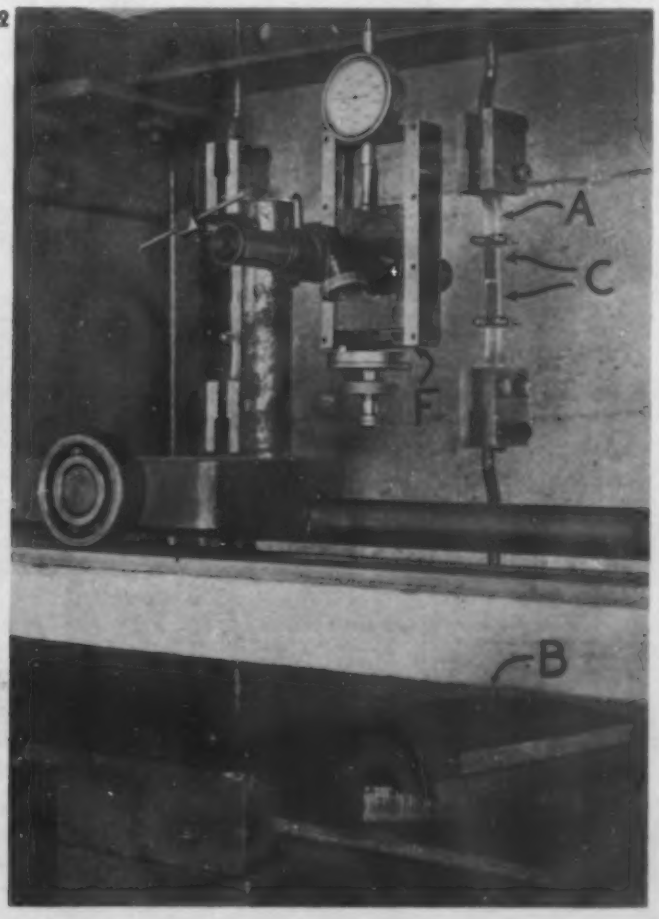
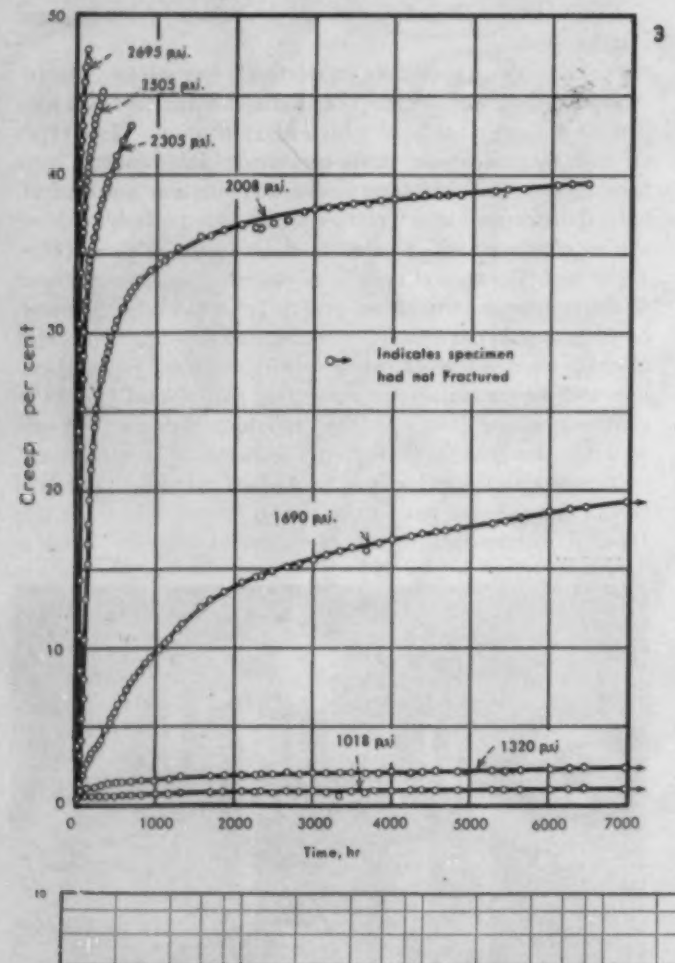


measuring creep with the electrical type of strain gage are presented in the paper by Telfair, Carswell and Nason (15).

The test results cited in the present paper were obtained by the use of both types of instruments. Tests conducted by Telfair, Carswell and Nason (15) were made with wire resistance-strip strain gages. The remainder of the test results presented in this paper were obtained by the author with the use of mechanical-lever-type strain-measuring instruments (14, 17), except in the case of cellulose acetate (12). The instrument used for tests of cellulose acetate is shown in Fig. 2 where the specimen *A* is subjected to dead load *B* and the deformation is measured by noting the change in spacing between the two brass clips *C*, each of which is fastened to the specimen. This change in displacement was measured by means of a traveling microscope *F*.



3

Creep of the various laminates tested by the author was obtained by means of instruments such as the unit shown in Fig. 1. In this figure the specimen *A* is subjected to dead load either directly or by means of a mechanical lever. Strain was measured by means of an extensometer consisting of a lever *B* and cathetometer *C*. A gage length of 4 in. was used with the specimen shown in Fig. 1. However, most of the tests reported were conducted on specimens having a 10-in. gage length.

Interpretation of creep test data

The method of interpretation of creep test data which is almost universally used in tests of metals is the representation of the creep or total strain by means of the equation:

$$\epsilon = \epsilon_0 + vt \qquad \text{(Equation 1)}$$

In the use of this equation the creep-time diagram is considered to consist of straight lines of constant slope, i.e., the extension due to creep is assumed to proceed at a constant rate. With this assumption a set of diagrams are constructed which are known as the McVetty diagrams. They consist of a linear plot of creep vs. time; a log-log plot of stress vs. rate of creep; and a linear plot of stress vs. total creep in one year's time (2).

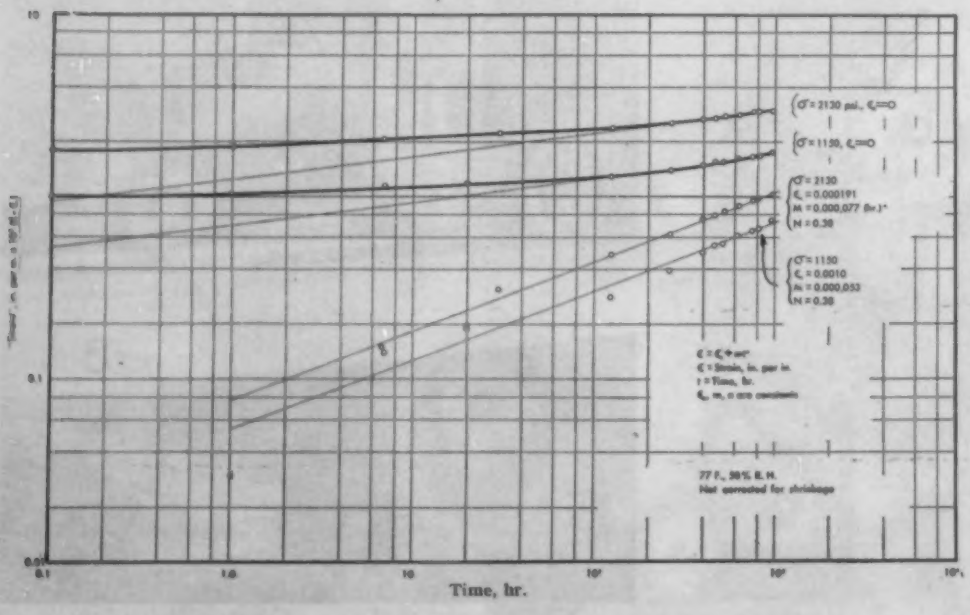
Figure 3 shows the creep-time diagram for tests of cellulose acetate (12) at several stresses, and a constant temperature and relative humidity. These data were plotted on linear coordinates, and it will be observed that the creep-time relationship is approximately linear only within a very limited region, although for low stresses the creep-time curve would appear to be a straight line.

Several investigators (9, 15, 18) have represented creep by means of the following equation:

$$\epsilon = \epsilon_0 + At + B \log t \qquad \text{(Equation 2)}$$

Because of the logarithmic term in this equation they have chosen to plot creep vs. time data on semi-logarithmic paper. However, as far as the author has been able to determine, there have been no attempts to establish that this relationship accurately represents creep behavior.

The purpose of the present paper is to present a mathematical equation which more accurately represents the creep-time behavior of plastics than either of the above-mentioned equations appears to do. The form of the equation



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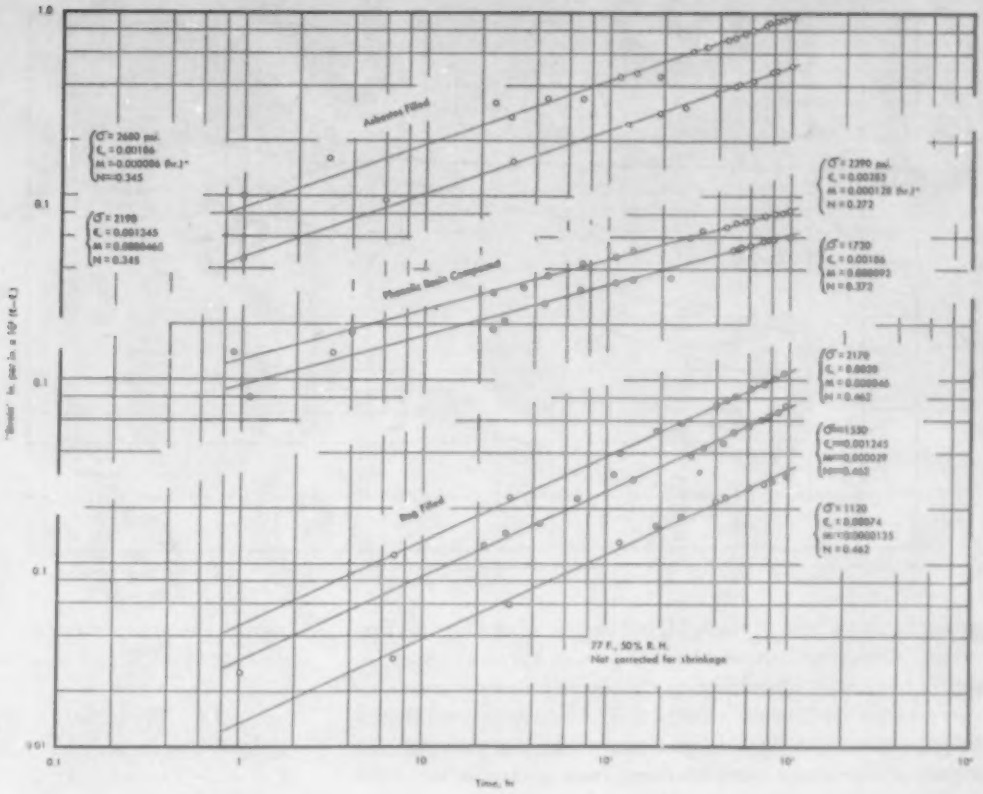
3—Creep versus time for tension creep tests of cellulose acetate at 77° F. and 50 percent relative humidity. *4—Log.-log. plot of strain versus time for tension creep tests of certain cord-filled phenolic materials (Monsanto data)*



5—A log.-log. plot of the strain versus time for tension creep tests of three different phenolic materials. (data supplied by Monsanto)

to be investigated is the power function:

$$\epsilon = \epsilon_0 + mt^n \qquad \text{(Equation 3)}$$

Comparison of this equation with Equation 1 indicates that Equation 1 is a special case of Equation 3 (Equation 3 being the more general case). Equation 1 may be obtained from Equation 3 by making the power n equal to 1. The "initial" strain ϵ_0 in Equations 1, 2 and 3 is not necessarily the elastic strain but is that value of strain required to make the equation fit the test data.

Application of power function

If the initial strain ϵ_0 is transferred to the left side of Equation 3 and the logarithm is taken of both sides of the equation, Equation 3 becomes:

$$\log (\epsilon - \epsilon_0) = n \log t + \log m \qquad \text{(Equation 4)}$$

This is an equation of a straight line in terms of $\log (\epsilon - \epsilon_0)$ and $\log t$—a fact which may be used to determine whether or not creep test data may be represented by a power function. If, for example, it is assumed that the initial strain ϵ_0 is 0, then a double logarithmic plot of creep ϵ against time t will yield a straight line if the data can be represented by a power function such as Equation 3 in which ϵ_0 equals 0. Such plots are shown by heavy lines in Fig. 4 for tension creep test of cord-filled phenolic (15). Since this diagram does not yield a straight line, it is evident that the equation:

$$\epsilon = mt^n \qquad \text{(Equation 5)}$$

does not fit the data shown. However, when a suitable ϵ_0 was subtracted from ϵ and the resulting data plotted against the time in hours, the result was the lower set of curves shown in Fig. 4. With this alteration the second plotting fits a straight line much better than the first plotting. It should be mentioned, however, that the subtraction of a value ϵ_0 greatly emphasizes any errors or variations in the test data. This is evident by the increased scatter in the second plotting as compared to the first plotting in Fig. 4. Thus we see that in this case the test data can be represented very well by an equation of the form of Equation 3 within the limits of experimental accuracy.

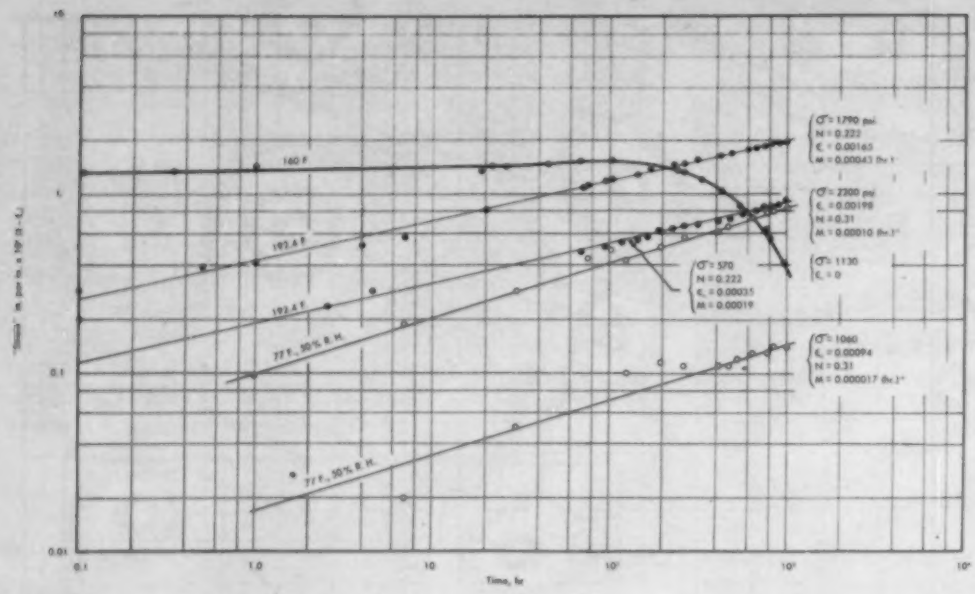
The determination of the proper value of ϵ_0 to make the test data fit a straight line on double log plotting may be accomplished by trial. However, the process may be facilitated by selecting three consecutive values of time, t_1, t_2, t_3, according to the relationship that the third value of time, t_3, equals $\sqrt{t_1 \times t_2}$. If then the values of strains ϵ_1, ϵ_2, ϵ_3 corresponding to these times be measured from the original plot of the data and substituted in the equation:

$$\epsilon_0 = (\epsilon_1\epsilon_2 - \epsilon_3^2)/(\epsilon_1 + \epsilon_2 - 2\epsilon_3) \qquad \text{(Equation 6)}$$

the value for ϵ_0 will be determined. This value may be considerably in error if the numerator or denominator of Equation 6 is a small difference. In such a case a more accurate value of initial strain may then be obtained by trial.

The value of the power n may be obtained by measuring the trigonometric slope of the straight line drawn through the plotted data. The value of the coefficient m may be obtained by determining from the straight line the value of strain corresponding to the time of one hour. For example the value of n in Fig. 4 is 0.38. The value of m is 0.000,077 $(\text{hr.})^{-n}$ for a stress of 2130 p.s.i. and the value of ϵ_0 is 0.00191 in./in. for the same stress.

It was observed in Fig. 4 and also in all test data to be shown later that the value of power n was the same for all stresses at a given temperature for the same material, i.e., n was independent of stress. Figure 5 shows a similar plot of strain difference $\epsilon - \epsilon_0$ against time for three different molded plastics—a phenolic resin compound, an asbestos-filled phenolic compound, and a rag-filled phenolic compound (15). These data also appear to obey a power law, Equation 3, fairly well. Figure 6 shows a similar plot for creep tests of a wood-flour-filled phenolic compound at three different temperatures: 77, 160, and 192.4° F. (15). Considerable shrink-



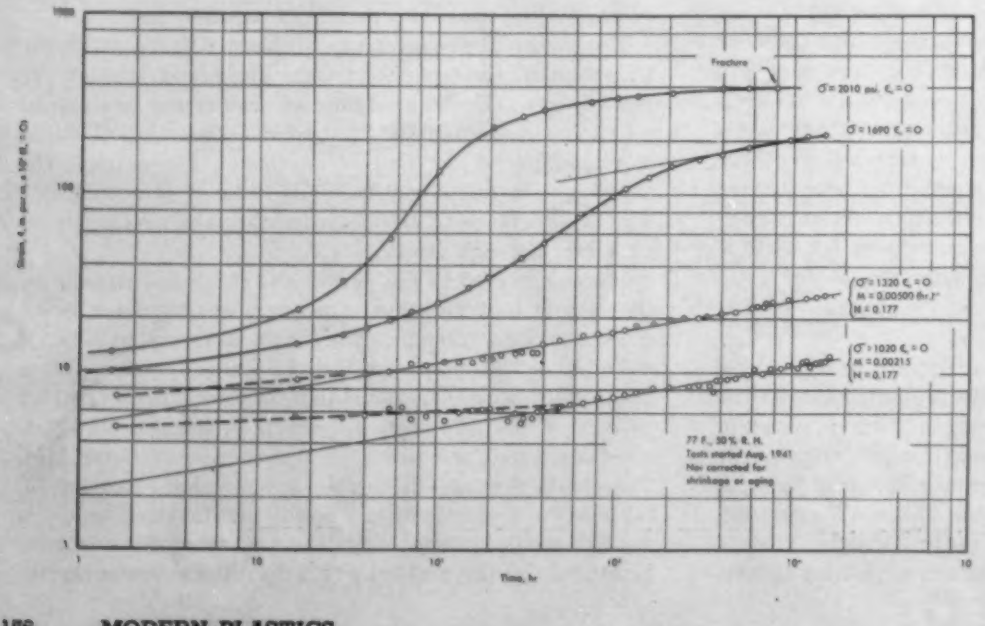
6—A log.-log. diagram of strain versus time for tension creep tests of wood-flour-filled phenolic at 3 different temperatures. (Data was supplied by Monsanto)

age occurred at both of these higher temperatures for this material. The creep measurements shown in Fig. 6 at 192.4° F. were corrected for shrinkage by the use of a dummy specimen (carrying no load) whose electrical strain gage was wired into the gage circuit of the test specimen in such a way that the output of the strain gage resulting from a change in length of the dummy specimen would be subtracted from the output of the strain gage on the test specimen. Since the dummy specimen and test specimen were subjected to the same temperature, the resulting output of the two gages indicated the strain of the test specimen as corrected for shrinkage.

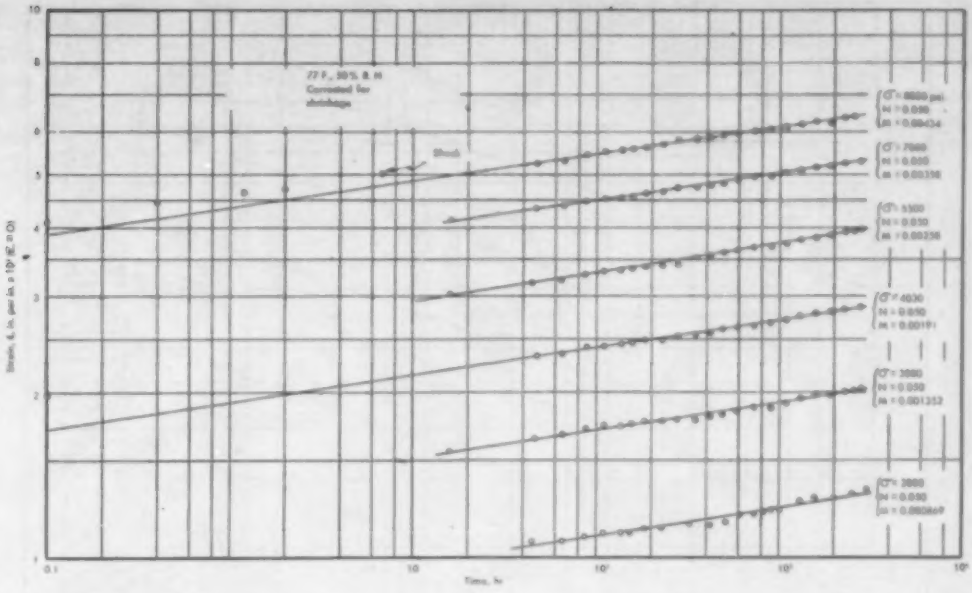
However, in the case of the test at 160° F. the investigators (15) used a dummy specimen which had been subjected to the test temperature much longer than the test specimen, with the result that shrinkage did not occur at the same rate in the two specimens and the indicated strain of the test specimen was only partly corrected for shrinkage. Because of this incomplete correction for shrinkage it was impossible to correlate the data at 160° F. with a power equation. It has been suggested by D. Telfair that the shrinkage observed at elevated temperatures may be the result of increase of cure or resin condensation.

Figures 7 through 11 show creep data on plastics obtained by the author at the University of Illinois. In Fig. 7 are shown the creep data for cellulose acetate (12), previously illustrated in Fig. 3 as a linear scale, replotted as a log.-log. plot. The value of ϵ_0 for Equation 3 found for these data was zero. These tests extended for a much longer time than tests shown in previous figures. The time interval involved was 17,000 hours. At low stresses (1690 and 2008 p.s.i.) the cellulose acetate creep test obeyed a power law quite well from the time interval of 100 to 17,000 hours. The disagreement at smaller times may have been caused by lack of sensitivity of strain measurement in the tests at these low stresses; high magnification extensometers were not used on the tests of cellulose acetate. At stresses of 1690 and 2008 p.s.i. the magnitude of creep of cellulose acetate was rather large—20 to 40 percent. With such a large extension the cross section of the specimen did not remain constant during the test but contracted appreciably so that the tension stress increased with time. Thus one might expect a different behavior under such conditions from that occurring under a constant stress. This is probably the explanation for the fact that the cellulose acetate creep curves for stresses which resulted in extensions of 20 percent and greater did not behave in accordance with the power law as did the creep at the lower two stresses.

Referring to Fig. 3, it was observed that the change in elongation of the specimens at the 1690 and 2008 p.s.i. stresses



7—A log.-log. diagram of the strain versus time for various tension creep tests of cellulose acetate material



8—A log.-log. plot representing strain versus time for some tension creep tests of Mitscherlich paper laminate

was not great after about 2000 hours. Thus the stress (based on the reduced area) was nearly constant beyond 2000 hours. However, because of the smaller area of cross-section the stress was higher than at the start of the test. It might be expected that for time beyond 2000 hr. the creep of these two tests might nearly follow the power law, and Fig. 7 shows this to be true. In this figure, the slope of the curve beyond 2000 hr. for $\sigma = 1690$ p.s.i. is the same as the curve for the low stresses.

In Fig. 8 are shown the tension creep data for six values of stress of a Mitscherlich paper laminate for values of stress from 2000 to 8000 p.s.i. (17). These data extend for more than 3000 hours. The light lines drawn through the test points are straight lines. The fact that all are parallel indicates that the power n is the same for all values of stress. In these data, as in the data for cellulose acetate, the value of ϵ_0 in Equation 3 was found to be equal to zero. These tests of Mitscherlich paper laminate show very good agreement with the power function for all six specimens tested. There is somewhat more irregularity in the data at low stresses than at high stresses due to the fact that the percentage change in strain caused by slight interruption of temperature or humidity control is more pronounced at small values of strain than at large values of strain.

In Fig. 9 is shown the log.-log. plot of tension creep tests of a Grade C canvas laminate for seven different values of stress ranging from 930 to 6650 p.s.i. These tests extended slightly over 2000 hours. As in the case of the previous figure, the light lines are straight lines and are all parallel, indicating that the value of n was the same for all values of stress. For the canvas laminate the value of ϵ_0 was not zero but took on values as indicated in Fig. 9. It might be noted that agreement with the power function law is indicated in tests shown in Figs. 8 and 9 by the good agreement between the test points and the straight lines.

Effect of stress on various factors in Equation 3

It has already been observed that the value of the power n was independent of the value of stress for a given material. In order to determine the effect of stress on the other factors in Equation 3, i.e., the coefficient m and the initial strain ϵ_0, various curve-fitting techniques were employed with the final result shown in Figs. 10 and 11. It was found that the coefficient m could be expressed as an exponential function of the stress. This is shown to be true in the following equation where:

$$m = C_2 (e^{k\sigma} - 1) \qquad \text{(Equation 7)}$$

If in this equation the constant term C_2 be transferred to the left-hand side and logarithms taken of both sides of the equation, then Equation 7 takes the following form:

$$\log_e (m + C_2) = k\sigma + \log_e C_2 \qquad \text{(Equation 8)}$$

This equation is a straight line in terms of the variables $\log_e (m + C_2)$ and stress σ. Thus a semi-logarithmic plot of the quantities $(m + C_2)$ and σ should yield a straight line if Equation 8 accurately represents the data, as is indicated by Fig. 10. The straight lines drawn in Fig. 10 are based on equations of the form of Equation 8 for these two materials. The values of the quantities C_2 and k were determined from the plotted data and are given in Fig. 10 and also in Table 1.

As pointed out above, the value of initial strain ϵ_0 was zero in the case of Mitscherlich paper laminate. For the Grade C laminate, values of ϵ_0 were nearly the same as the values of m, suggesting that they may vary in accordance with the same function, that is:

$$\epsilon_0 = C_2 (e^{k\sigma} - 1) \qquad \text{(Equation 9)}$$

That this expression is reasonably accurate is shown in Fig. 10 by values of $(\epsilon_0 + C_2)$ plotted as filled circles. If then it be assumed that $\epsilon_0 = m$ for the Grade C laminate, Equation 3 may be written as a function of stress as follows:

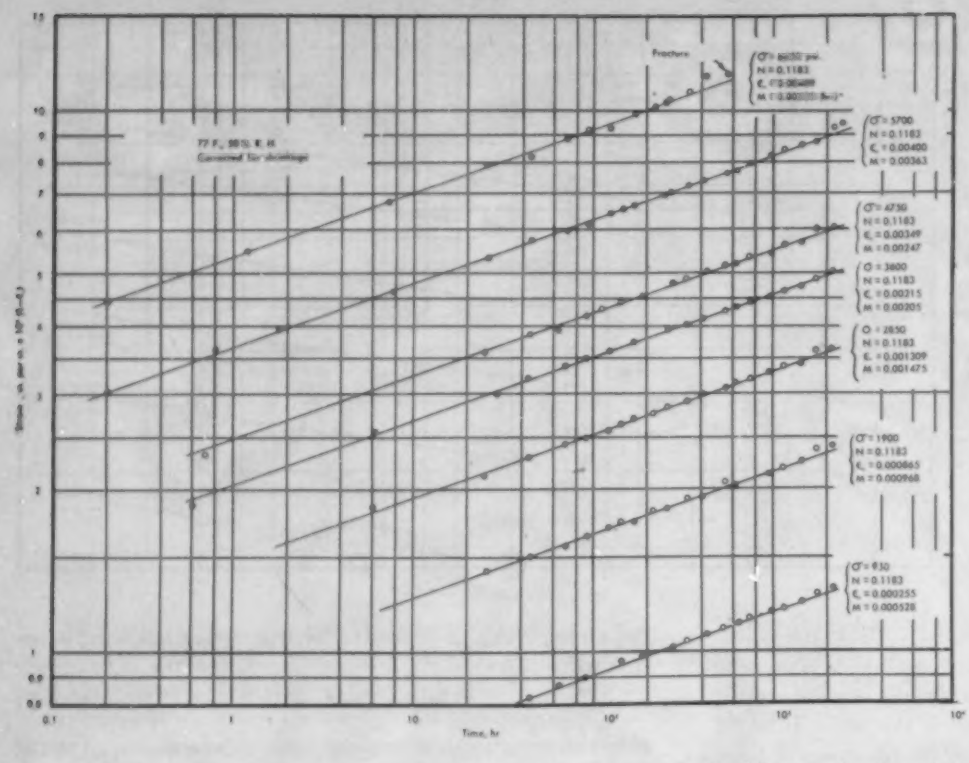
$$\epsilon = C_2 (e^{k\sigma} - 1)(1 + t^n) \qquad \text{(Equation 10)}$$

However, since the Mitscherlich paper laminate gave a value of initial strain ϵ_0 of zero for all values of stress, the condition represented by Equation 10 cannot be considered a general expression for all materials.

The initial strain ϵ_0 is not the same as the elastic strain but is larger than the elastic strain for the Grade C material, and is not a linear function of stress, as indicated by Equation 9. Unfortunately, there is enough scatter in the data for ϵ_0 so that the exact form of the equation cannot be determined. For example ϵ_0 can be equally well represented by the power equation:

$$\epsilon_0 = C_1 \sigma^N \qquad \text{(Equation 11)}$$

This equation is represented on double logarithmic paper by a straight line as shown in Fig. 11. The constants C_1 and N



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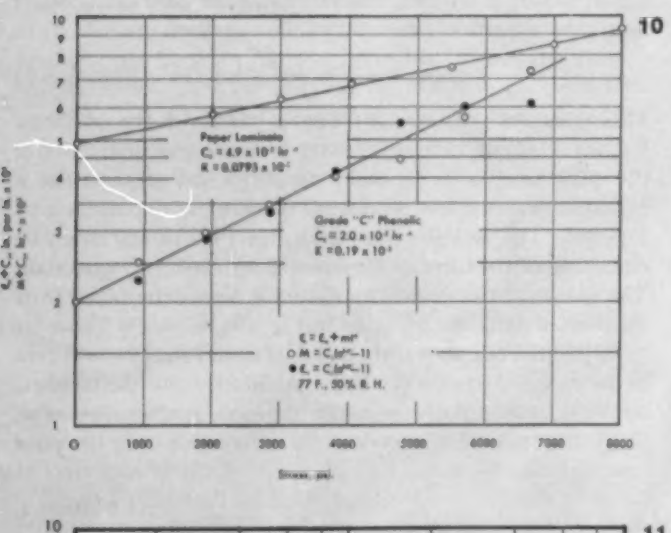
9—A log.-log. plot of strain versus time for tension creep tests of Grade C canvas laminate. **10**—*A semi-log. diagram of "initial" strain ϵ_0 and coefficient* m *versus stress* σ *for tension creep tests of two laminates.* **11**—*A log.-log. plot of "initial" strain ϵ_0, versus stress* σ *for tension creep tests of Grade C canvas laminate*



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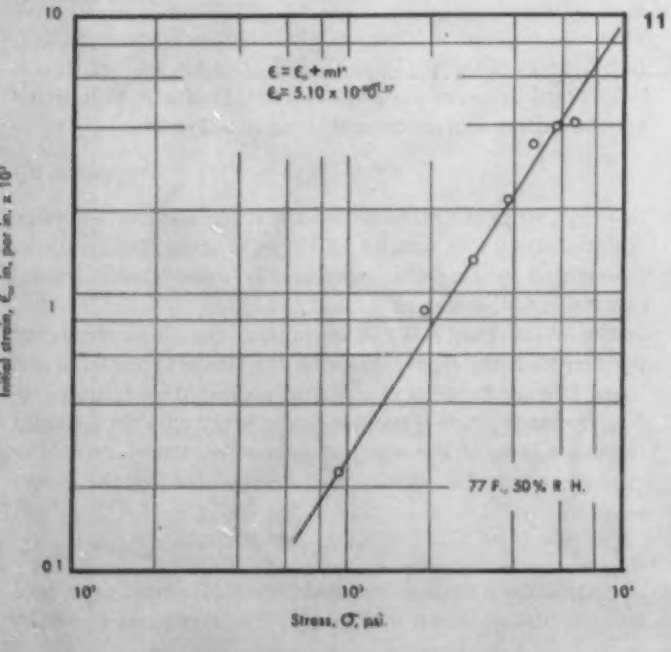


11

for this equation have been evaluated in Fig. 11 and in Table 1.

The fact that the initial strain ϵ_0, calculated from the creep data according to Equation 3, does not correspond to the elastic strain σ/E may be due in part to the fact that ϵ_0 was determined on the assumption that the stress σ was constant for the entire test from zero time, and σ/E was determined on the assumption that time was constant, whereas neither condition was true during the tests used to determine their respective values. As the load was applied to the specimen at the start of a creep test, the stress increased during a certain time interval. Thus, during this time interval elastic strain was taking place and also continuing deformation was proceeding under conditions of increasing rather than constant stress. The effect of this departure from the conditions imposed by the definition of creep may be expected to influence the creep behavior for at least a short time after the load has reached the final value. This effect is reflected in the difference between ϵ_0 and σ/E. Other factors which may contribute to this difference are residual stresses and fiber orientation.

The effect of uncontrolled factors

According to the definition of creep cited above, an equation such as Equation 10 should indicate the total creep ϵ as a function of the elapsed time during which the tension stress remained constant. All other factors which might affect the deformation must remain fixed, and in order to evaluate the constants in Equation 10 the creep tests must be conducted under conditions which will exclude all variables other than the ones under study.

Practically, this condition is impossible to fulfill. For example, in the creep tests of plastics discussed herein the relative humidity was maintained substantially constant during the tests, as was the temperature, but actually it is not the relative humidity of the surrounding atmosphere but the moisture content of the specimens which should be kept constant. If the moisture content at the start of the tests is not the equilibrium value for the test atmosphere, which is usually the case, then the moisture content will change gradually during the test. (*Please turn to page 194*)

TABLE I.—CREEP CHARACTERISTICS OF SEVERAL PLASTICS

(Based on the Power Equations: $\epsilon = \epsilon_0 + mt^n$ or expressed as a Function of Stress: $\epsilon = C_1\sigma^N + C_2(e^{k\sigma} - 1)t^n$ or $\epsilon = C_2(e^{k\sigma} - 1)(1 + t^n)$

Material	Laboratory	*Static properties at 77° F. and 50 percent R. H.*		*Creep properties*										
		Modulus of elasticity, E	*Tensile strength*	*Tension stress, σ*	*Total creep at 1000 hr., ϵ_{1000}*	*Initial creep, ϵ_0*	*$C_1 \times 10^9$ (p.s.i.)$^{-N}$*	*N (dimensionless)*	*Coefficient $m \times 10^3$ (hr.)$^{-n}$*	*$C_2 \times 10^3$ (hr.)$^{-n}$*	*$k \times 10^3$ (in.^{2}/lb.)*	*Power n (dimensionless)*	*Temperature*	*Relative humidity*
		10^6 p.s.i.	*p.s.i.*	*p.s.i.*	*10^{-3} in./in.*	*10^{-3} in./in.*							*° F.*	percent
1. Mitscherlich paper laminate, Fig. 8	Univ. of Illinois	2.27	19,600 (strain rate 0.0015 per min.)	8000	5.98	0.0	..	..	4.34	4.9	0.0795	0.050	77	50
				7000	4.89				3.58					
				5500	3.61				2.58					
				4030	2.58				1.91					
				3000	1.80				1.352					
				2000	1.11				0.869					
2. Grade C canvas laminate, Fig. 9	Univ. of Illinois	1.08	10,700 (strain rate 0.0015 per min.)	6650	..	4.09	5.10	1.57	5.35	2.0	0.191	0.118	77	50
				5700	12.3	4.00			3.63					
				4750	9.1	3.49			2.47					
				3800	6.70	2.15			2.05					
				2850	4.60	1.309			1.475					
				1900	3.05	0.865			0.968					
				930	1.45	0.255			0.528					
3. Cellulose acetate sheet, Fig. 7	Univ. of Illinois	0.212	4,700 (strain rate 0.0015 per min.)	2010	345.0	0.0	..	..	..	...	...	...	77	50
				1690	98.0				..					
				1320	10.7				5.00			0.177		
				1020	7.2				2.15			0.177		
4. Asbestos-filled phenolic molding compound, Fig. 5	Monsanto	1.35 to 1.65	5,700	2680	2.83	1.86	..	..	0.086	...	...	0.345	77	50
				2190	1.86	1.345			0.465					
5. Woodflour-filled phenolic molding compound, Fig. 6	Monsanto	1.05 to 1.25	6,100	1790	3.60	1.65	..	..	0.43	...	...	0.222	192.4	..
				570	1.26	0.35			0.19			0.222	192.4	..
				1130	..	0.0			...			..	160	..
				2200	2.82	1.98			0.10			0.31	77	50
				1060	1.08	0.94			0.017			0.31	77	50
6. Rag-filled phenolic molding compound, Fig. 5	Monsanto	1.05 to 1.35	6,100	2170	3.08	2.00	..	..	0.046	...	...	0.462	77	50
				1550	1.97	1.245			0.029					
				1120	1.04	0.74			0.0135					
7. Cord-filled phenolic molding compound, Fig. 4	Monsanto	0.95 to 1.15	6,000	2130	2.95	1.91	..	..	0.077	...	...	0.38	77	50
				1150	1.75	1.0			0.053					
8. Phenolic resin compound, Fig. 5	Monsanto	0.75 to 0.90	8,900	2390	3.68	2.85	..	..	0.128	...	...	0.272	77	50
				1730	2.46	1.86			0.093					

NOTE: Values are indicated for the highest stress only when the quantity is the same for all tests of the material.

Resorcin resins and adhesives*

by PHILIP H. RHODES**

EVER since the beginning of the synthetic resin industry, it has been known that resorcinol (meta-hydroxyphenol) will react with formaldehyde to give resins analogous to the phenol-formaldehyde type. Because this resin-forming reaction is one of substitution in the benzene ring, resorcinol reacts much more strongly than phenol. The reason for this greater reactivity is well known to the organic chemist. When groups such as the hydroxyl are present in the benzene ring, the ortho and para positions are much more reactive than the meta. When, as is the case with resorcinol, a meta position also contains an ortho-para directing group, the reactivity of these positions is intensified. This comparison is illustrated diagrammatically in Fig. 1.

Until a relatively short time ago resin formation with resorcinol was practically impossible to control. The reaction, when carried out under the same conditions as with phenol and formaldehyde, proceeded almost explosively to the fully cured resin. Attempts to fit the conditions to the reaction rate did finally result in intermediate uncured resins, and the use of resorcinol as a modifier with phenol-formaldehyde as well as with urea-formaldehyde resins has become a well-recognized practice.

It became apparent to the producers of resorcinol that if, in order to obtain an uncured intermediate, it was necessary to retard the progress of the reaction, it should be possible to effect the final cure of this intermediate with relative ease and that such a product would be of great value either as a casting resin or, much more significantly, as an adhesive.

To understand the significance of this latter use, it is helpful to review the development of adhesives since the first World War. At that time plywood as well as glued assemblies found wide application in the aircraft industry. During that war, casein adhesives attained great popularity and offered serious competition to the traditional animal glues. For some time after the war intensive research was devoted to casein glues for the purpose of obtaining formulations with greater water resistance.

With the advent of the resin industry, however, urea-formaldehyde syrups were developed which could be set at room temperature to effect bonds having greater water resistance than the natural products. But it was soon discovered that the incorporation of acid catalysts, necessary for the cure at room temperature, was responsible for a slow but significant deterioration of the resin itself which eventually resulted in a deterioration of the glue line. Similar adhesives have also been prepared from phenol-formaldehyde resins employing acid catalysts for the final cure. Although phenolic resins are resistant to attack by acids, it is necessary to use them in such strength for room temperature cure that the wood is decomposed. These problems have been eliminated to a large extent by the use of intermediate temperatures and less concentrated acids as well as by the addition of modifiers such as resorcinol.

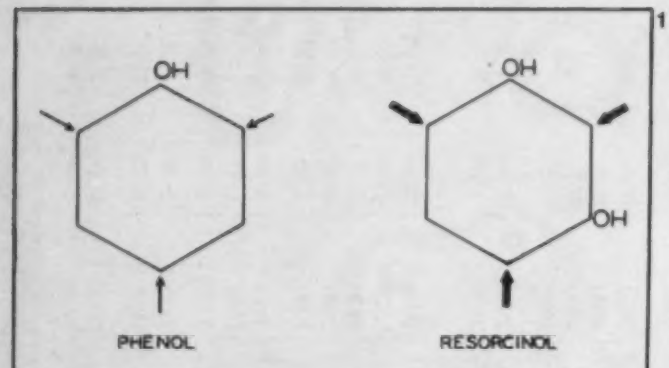
More recently through the development of resorcinol-formaldehyde glues, such as Penacolite[1] G-1124 and G-1131,

* Presented before the Annual Conference of the Society of the Plastics Industry, New York, N. Y., on Nov. 13.

** Chief of resin research, Pennsylvania Coal Products Co.

[1] Trade name, Pennsylvania Coal Products Co.

1



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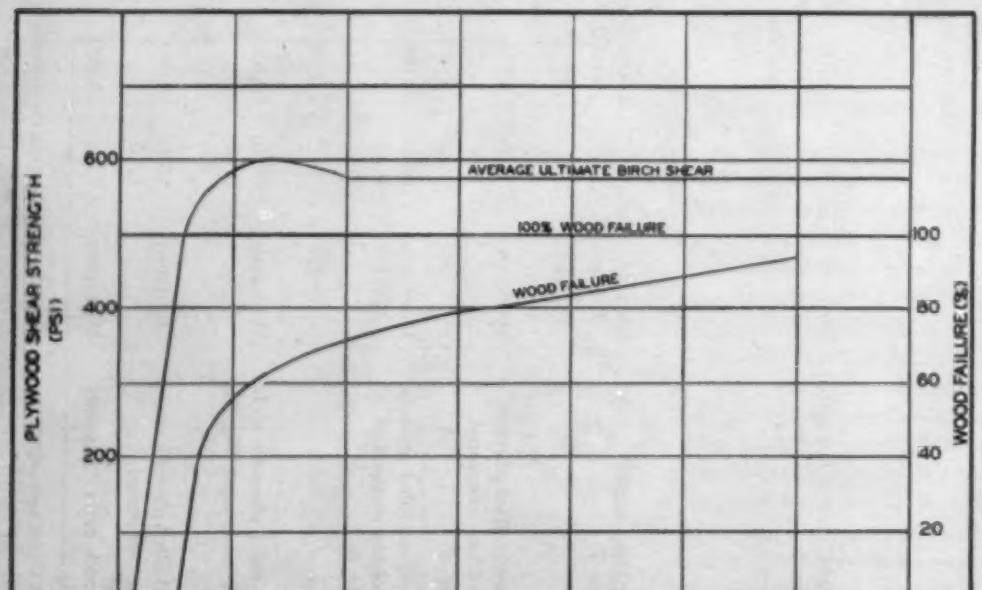
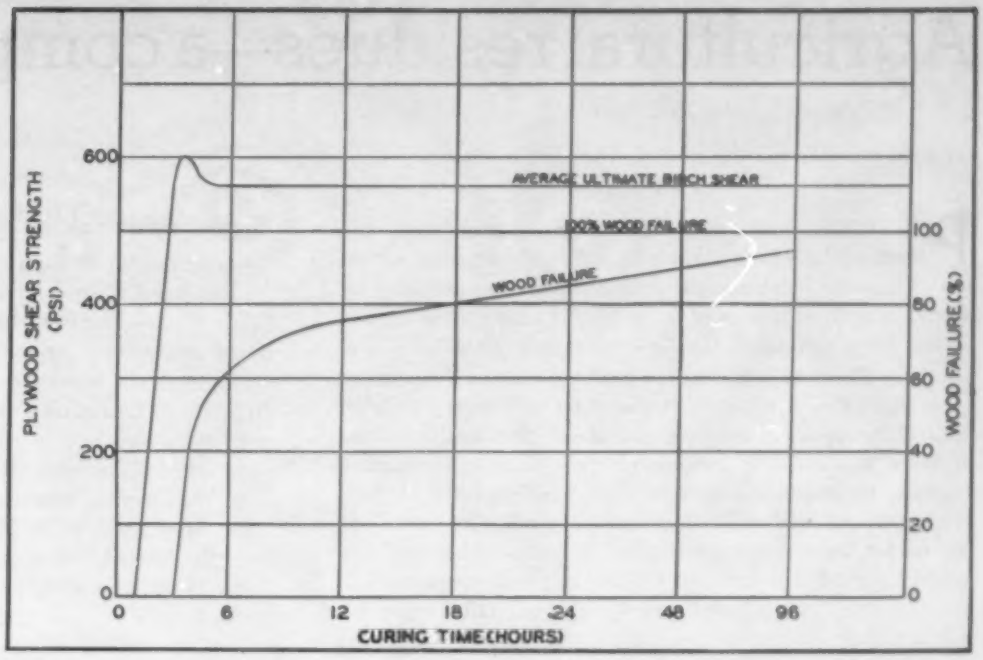


1—A diagrammatic illustration of the relative reactivity of phenol and resorcinol. 2—Effect of time of cure on shear strength of G-1124, the first of the resorcinol adhesives that was developed



3—The time required to obtain the full strength of resorcinol adhesive G-1131 is shown in this diagram

bonds are obtained which are completely waterproof and non-corrosive. To effect complete cure it is necessary to add only formaldehyde solution or para-formaldehyde powder. The glue solution and film are neutral or very slightly alkaline.

The initial experimental work which indicated the promise of success in research on this subject was conducted by Arthur J. Norton for the manufacturer of Penacolite. When the program was begun, it was felt that previous failures indicated the need for fundamentally new methods of approach to the problem in order to create the properties which resorcin resins should theoretically possess. The special techniques developed during the investigation are covered by secrecy orders from the U. S. Patent Office and for that reason may not be disclosed. The properties of the resins, however, are becoming familiar to many users. Paper and fabric laminates have been prepared with physical properties of greater strength than similar materials made with phenol-formaldehyde resins. Another superior application is found in the manufacture of grinding wheels where length of wear and efficiency are twice that given by phenol-formaldehyde resins.

The first resorcinol adhesive developed by this process was G-1124, which can be set by the addition of aqueous formaldehyde solution. The time required for development of full strength in birch plywood at room temperature is shown in Fig. 2. The primary disadvantage in G-1124 was the irritating effect of the free formaldehyde. This is overcome in G-1131 by the use of para-formaldehyde powder which reacts with the resin as it decomposes into formaldehyde. The time required to obtain the full strength of this adhesive is shown in Fig. 3.

The pot life of a resorcin resin adhesive at room temperature is shown in Fig. 4 which represents the increase in viscosity on standing after the formaldehyde is added. Other properties of the resorcinol resin adhesives are recorded in Table I.

Although these adhesives were originally developed for room temperature bonding, it has been found that increased temperature greatly accelerates cure. For example, at a glue-line temperature of 180° F., cure is effected in 5 to 6 minutes. By using high frequency heating, cures of 1 min. have been attained. The use of higher than room temperatures is particularly prevalent in the manufacture of heavy laminated timbers such as have been employed in the small boat program being undertaken by the Bureau of Ships of the U. S. Navy Department. One of the leading producers in this field is Gamble Brothers in Louisville who, in cooperation with the U. S. Forest Products Laboratory, have shown that with these resins temperatures as low as 140° F. are sufficient for the production of laminated white oak timbers for ship use. No severer test is known than the actual service conditions for which these laminated beams are used, e.g., keels, ribs, skegs, etc. Wide application has also been found in the production of plywood tubing.

In addition to wood, resorcinol (*Please turn to page 198*)

TABLE I.—PROPERTIES OF PENACOLITE RESIN ADHESIVES

Property	*G-1124*	*G-1131*[a]
Adhesive base	Heavy brown viscous liquid	Wine-colored solution
Setting agent	Pale pink liquid	Tan powder
Storage life	Indefinite	Indefinite
Mixture: parts base to 1 part setting agent	4	5
pH of mixture	6.8–6.9	7.2–7.3
Working life at 75 to 80° F., hr.	3–3½	3 hr.
Curing time at 75 to 80° F.:		
To handling, hr.	6–24	4–16
To complete durability, hr.	48–96	24–72
Required pressure	Intimate contact; usually 50 p.s.i. minimum in production	Intimate contact; 50 p.s.i in production
Properties of bond:		
pH	6.9–7.0	7.0
Effect of boiling water	Boilproof	Boilproof
Strength in thick glue lines	Strong	Strong
Attack by fungi or insects	Unaffected	Unaffected

[a] This adhesive complies with the following specifications: Army Air Force 14124, Naval Aircraft G-33, Bureau of Ships 52G-12, Canadian and British Specifications.

Agricultural residues—a comparative stud

by T. F. CLARK and S. I. ARONOVSKY*

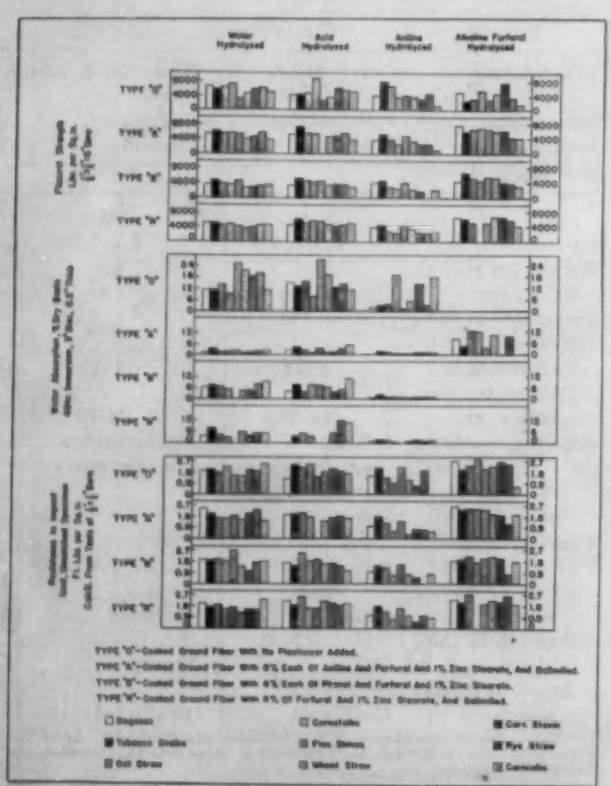
PREVIOUS publications from the Agricultural Byproducts Laboratory[1] have reported investigations on the use of bagasse in plastic molding compositions prepared by digestion with sulfuric acid (2, 14),[2] and with aniline (2, 13). It has been estimated that approximately 84,000,000 tons annually of agricultural residues from cultivation (i.e., straws, cobs, hulls, stalks, etc.) are available for industrial use in the United States (19). As the physical and chemical properties of these residues are, in general, very similar to those of bagasse, their molding compositions were expected to have characteristics and molded properties similar to those observed for bagasse compositions. A comparative study of several agricultural residues for use in plastic compositions was initiated. It included corn stover, cornstalks, corncobs, wheat straw, oat straw, rye straw, flax shives, sugarcane bagasse, tobacco stalks, and hydrolyzed oat hull residue resulting from furfural manufacture.

The major portion of this work was conducted in the Agricultural Byproducts Laboratory prior to the transfer of the project and personnel to the Northern Regional Research Laboratory. While the results have led only to tentative conclusion, they may be of help to others working in this field.

* Northern Regional Research Laboratory, Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Dept. of Agriculture.

[1] Established by the Bureau of Agricultural Chemistry and Engineering, U. S. Dept. of Agriculture, in cooperation with the Iowa State College, Ames, Iowa. The Agricultural Byproducts Laboratory was transferred to the Northern Regional Research Laboratory, Peoria, Illinois, on July 1, 1941, and its work is being continued there by the Agricultural Residues Division.

[2] Numbers in parentheses refer to the references that are listed at the end of this paper.


Water Hydrolyzed
Acid Hydrolyzed
Aniline Hydrolyzed
Alkaline Furfural Hydrolyzed
TYPE 'D'
TYPE 'A'
TYPE 'B'
TYPE 'W'
TYPE 'D'-Cooked Ground Fiber With No Plasticizer Added.
TYPE 'A'-Cooked Ground Fiber With 8% Each Of Aniline And Furfural And 1% Zinc Stearate, And Ballmilled.
TYPE 'B'-Cooked Ground Fiber With 8% Each Of Phenol And Furfural And 1% Zinc Stearate.
TYPE 'W'-Cooked Ground Fiber With 8% Of Furfural And 1% Zinc Stearate, And Ballmilled.
Bagasse
Cornstalks
Corn Stover
Tobacco Stalks
Flax Shives
Rye Straw
Oat Straw
Wheat Straw
Corncobs

1

1—*Flexural strength, water absorption and resistance to impact of products molded from water-, acid-, aniline- and alkaline-furfural-hydrolyzed agricultural residues. Water absorption values have not been presented in cases where values were unreasonably high, as for alkaline-furfural-hydrolyzed materials, and where the products were not tested because of the non-uniformity of cure*

Preparation of molding powders

Numerous methods of treating lignocellulosic residues, including wood wastes, for use in plastics have been suggested (1, 7–18, 20–23). For the comparative study of the suitability of various agricultural residues for use in plastics, three methods previously investigated at the Agricultural Byproducts Laboratory were selected. These three methods were as follows:

a. Hydrolysis with 1 percent sulfuric acid for 30 min. at 358° F. (135 p.s.i. steam pressure) (2, 14).

b. Hydrolysis with 21 percent aniline for 180 min. at 384° F. (190 p.s.i. steam pressure) (2, 13).

c. Hydrolysis with 30 percent caustic soda and 12 percent furfural for 8 hr. under reflux conditions, followed by acidification and boiling with sulfuric acid at pH 4, filtration, and washing of the pulp and coagulated lignin (2, 14).

A fourth method—hydrolysis with water for 60 min. at 366° F. (150 p.s.i. steam pressure)—was also investigated.

Water to dry fiber ratio was 3.75 to 1 in all methods except (c) in which a ratio of 15 to 1 was required to cover the fiber. The effects of the four methods of treatment on yield and on the benzene-alcohol extractives and ash, lignin and pentosan contents are presented in Table II.

The lignocellulosic fibers that remained after hydrolysis were filtered, washed, dried and ground in a rotary cutting mill to pass a screen having 1-mm. round openings (14). Each type of ground cooked fiber was divided into four portions of approximately 2.5 lb. each. One portion was used without further treatment and the other three were "plasticized" with the following reagents: 8 percent each (based on the dry cooked fiber) of aniline and furfural; 8 percent each of phenol and furfural; and 8 percent of furfural. One percent of zinc stearate was added for lubrication and ease of release of the product from the molds. These materials were mixed for 30 min. in a pebble mill, as described in the investigation on aniline bagasse plastics (13), and stored in friction-seal cans.

Molding

As most of the molding compositions that were prepared exhibited some thermoplastic properties, the molds were cooled before the test specimens were removed. All molding was done at a pressure of 4500 p.s.i. and a temperature of 160 to 165° C. (320 to 329° F.) during the curing period. The compositions were placed in the molds at 120 to 125° C. (248 to 257° F.) and maintained under pressure throughout the heating, curing and subsequent cooling periods. Specimens were ejected at a temperature of 125° C., or lower, as required.

A.S.T.M. standard 0.5 by 0.5 by 5 in. test bars (3, 4) for

TABLE I.—PHYSICAL CHARACTERISTICS OF MOLDING COMPOSITIONS AND MOLDED PRODUCTS[a]

Residue		Corn stover	Corn stalks	Corn-cobs	Wheat straw	Oat straw	Rye straw	Flax shives	Bagasse	Tobacco stalks
WATER-COOKED FIBER										
Flexural strength,[b] p.s.i.	Max.	5860	7350	5110	4750	6500	6570	3235	6730	6060
	Min.	5570	6870	5055	4390	5890	5480	3110	6210	5345
	Av.	5715	7110	5080	4610	6250	6025	3170	6470	5700
Impact strength,[c] Izod unnotched, ft.-lb./sq. in.	Max.	2.43	2.97	3.53	1.67	2.03	2.23	1.63	2.07	2.54
	Min.	1.40	1.93	1.17	1.47	1.67	1.67	1.53	1.73	1.33
	Av.	2.00	2.26	2.50	1.53	1.80	1.90	1.57	1.95	2.03
Water absorption,[d] 48-hr. immersion, dry basis, percent		18.7	9.3	11.3	22.0	14.1	20.4	25.8	11.6	11.2
Hardness,[f] Rockwell "H"		79	79	87	68	90	78	73	95	100
Specific gravity[e]		1.382	1.380	1.391	1.388	1.400	1.385	1.355	1.393	1.419
Bulk factor		11.5	15.0	5.85	8.47	12.4	11.5	7.46	8.57	9.24
Molding quality[b]		P	P	P	P	P	P	P	P	P
WATER-COOKED FIBER + 8 PERCENT ANILINE + 8 PERCENT FURFURAL										
Flexural strength,[b] p.s.i.	Max.	4770	5970	4690	4020	5680	6460	5780	5950	6415
	Min.	4330	5030	2890	3860	5240	5450	4100	5230	6040
	Av.	4490	5690	3770	3940	5425	5780	5230	5710	6220
Impact strength,[c] Izod unnotched, ft.-lb./sq. in.	Max.	2.80	2.43	2.97	2.3	2.60	2.67	3.23	4.24	3.07
	Min.	1.50	1.17	0.72	0.88	1.10	1.40	1.70	1.30	1.27
	Av.	2.06	1.67	1.47	1.57	1.67	2.33	1.90	2.46	2.04
Water absorption,[d] 48-hr. immersion, dry basis, percent		1.94	2.20	2.88	1.6	1.96	2.25	2.8	1.8	3.60
Hardness,[f] Rockwell "H"		94	95	92	81	90	96	95	95	95
Specific gravity[e]		1.404	1.397	1.411	1.438	1.397	1.437	1.371	1.406	1.447
Bulk factor		4.26	6.72	4.05	4.72	5.65	5.04	4.69	5.30	5.38
Molding quality[b]		F	F	F-G	G	G	F	P-F	P-F	G
WATER-COOKED FIBER + 8 PERCENT PHENOL + 8 PERCENT FURFURAL										
Flexural strength,[b] p.s.i.	Max.	3290	4070	3800	2620	3960	3700	4800	3800	5080
	Min.	2210	2220	2600	2610	3440	2700	3950	3440	4170
	Av.	2780	3440	3260	2615	3770	3170	4490	3670	4650
Impact strength,[c] Izod unnotched, ft.-lb./sq. in.	Max.	1.40	3.26	3.06	1.67	3.00	2.30	3.47	2.96	2.53
	Min.	0.67	1.07	0.93	1.17	1.27	0.90	1.57	0.84	1.10
	Av.	1.03	1.87	1.83	1.40	2.03	1.73	2.70	1.97	1.93
Water absorption,[d] 48-hr. immersion, dry basis, percent		4.65	5.29	9.5	4.38	6.84	8.03	*	6.55	7.2
Hardness,[f] Rockwell "H"		80	79	72	58	75	70	91	77	88
Specific gravity[e]		1.451	1.413	1.419	1.410	1.393	1.403	1.387	1.419	1.424
Bulk factor		4.04	4.79	3.61	4.37	4.73	4.44	4.81	5.93	4.98
Molding quality[b]		F-G	F-G	F-G	G	G	F	P-F	P-F	G
WATER-COOKED FIBER + 8 PERCENT FURFURAL										
Flexural strength,[b] p.s.i.	Max.	3990	5220	4920	3730	4750	4740	5640	5620	5570
	Min.	3810	3930	4390	3450	4100	4150	3240	4790	4870
	Av.	3890	4750	4630	3590	4540	4460	4260	5120	5100
Impact strength,[c] Izod unnotched, ft.-lb./sq. in.	Max.	2.43	2.46	3.07	1.97	2.86	2.73	2.46	2.93	2.50
	Min.	0.77	1.07	1.67	0.77	1.27	1.03	1.13	1.23	1.0
	Av.	1.57	1.57	2.33	1.27	1.93	1.50	1.67	2.03	1.73
Water absorption,[d] 48-hr. immersion, dry basis, percent		3.96	2.93	5.0	5.7	4.2	5.03	*	3.77	7.7
Hardness,[f] Rockwell "H"		89	92	93	77	83	82	95	88	89
Specific gravity[e]		1.463	1.429	1.426	1.479	1.417	1.464	1.27—1.45	1.444	1.474
Bulk factor		5.51	5.24	3.98	4.52	5.4	4.8	4.5	6.05	5.12
Molding quality[b]		F-G	F-G	F-G	F-G	G	F	P-F	P-F	G

Residue		Corn stover	Corn stalks	Corn-cobs	Wheat straw	Oat straw	Rye straw	Flax shives	Bagasse	To-bacco sta
ACID-HYDROLYZED FIBER										
Flexural strength,[b] p.s.i.	Max.	7070	9100	5200	4190	4970	5640	3250	5140	48
	Min.	5520	8420	5000	2890	4810	5170	1670	3790	37
	Av.	6100	8820	5100	3510	4890	5330	2400	4240	42
Impact strength,[c] Izod unnotched, ft.-lb./sq. in.	Max.	2.63	2.63	2.17	1.70	2.33	2.00	1.67	1.97	2.
	Min.	1.87	2.33	1.50	1.37	2.06	1.77	1.20	0.90	2.
	Av.	2.06	2.50	1.73	1.87	2.16	1.90	1.43	1.30	2.
Water absorption,[d] 48-hr. immersion, dry basis, percent		12.7	7.95	11.4	19.5	16.1	14.5	28.0	15.6	13
Hardness,[f] Rockwell "H"		88	96	80	74	83	89	55	84	
Specific gravity[e]		1.400	1.395	1.418	1.391	1.390	1.388	1.358	1.382	1.3
Bulk factor		11.9	14.0	5.28	8.8	11.0	10.4	7.4	7.35	11
Molding quality[b]		P	P	P	P	P-F	P	P	P	
ACID-HYDROLYZED FIBER + 8 PERCENT ANILINE + 8 PERCENT FU										
Flexural strength,[b] p.s.i.	Max.	4690	5620	4070	4870	5860	5730	..	5670	72
	Min.	4590	5470	3640	4290	5250	5530	..	4900	68
	Av.	4640	5550	3850	4510	5560	5610	..	5290	71
Impact strength,[c] Izod unnotched, ft.-lb./sq. in.	Max.	2.13	1.90	1.97	2.26	2.67	2.43	..	2.33	3.
	Min.	1.03	1.67	1.17	0.70	0.97	1.17	..	1.30	1.
	Av.	1.73	1.77	1.67	1.43	2.10	1.80	..	1.97	2.
Water absorption,[d] 48-hr. immersion, dry basis, percent		1.94	1.38	5.5	1.96	2.94	3.59	4.0	3.1	4
Hardness,[f] Rockwell "H"		91	91	84	90	92	90	93	95	
Specific gravity[e]		1.425	1.403	1.409	1.453	1.412	1.405	1.340	1.430	1.4
Bulk factor		4.66	5.74	3.44	4.20	4.79	5.21	4.44	4.79	4.
Molding quality[b]		F-G	F-G	P-F	F-G	G	G	F-G	F-G	
ACID-HYDROLYZED FIBER + 8 PERCENT PHENOL + 8 PERCENT FU										
Flexural strength,[b] p.s.i.	Max.	4310	4230	3010	3580	4580	3590	4600	3260	51
	Min.	2730	4130	2740	3010	4370	3300	4150	3210	48
	Av.	3550	4180	2880	3210	4510	3450	4370	3230	50
Impact strength,[c] Izod unnotched, ft.-lb./sq. in.	Max.	2.20	2.64	1.87	2.46	3.33	1.83	3.93	2.00	1.8
	Min.	1.17	1.10	0.50	0.63	2.00	0.87	1.17	1.53	1.1
	Av.	1.63	1.83	1.07	1.60	2.50	1.43	1.97	1.73	1.4
Water absorption,[d] 48-hr. immersion, dry basis, percent		3.69	7.9	10.8	6.3	3.8	4.9	7.6	4.06	7.7
Hardness,[f] Rockwell "H"		84	74	62	72	82	68	83	77	8
Specific gravity[e]		1.396	1.384	1.427	1.418	1.399	1.413	..	1.427	1.41
Bulk factor		4.01	5.37	3.37	3.91	4.22	4.31	4.26	3.96	5.3
Molding quality[b]		F-G	F-G	P-F	F-G	G	G	F-G	F-G	
ACID-HYDROLYZED FIBER + 8 PERCENT FURFURAL										
Flexural strength,[b] p.s.i.	Max.	4400	5680	5180	4680	5370	4560	5850	5010	643
	Min.	3870	5680	4660	4420	4430	4510	5250	4170	596
	Av.	4080	5680	4930	4580	5000	4540	5520	4690	620
Impact strength,[c] Izod unnotched, ft.-lb./sq. in.	Max.	2.53	2.00	2.36	3.20	3.70	2.30	1.90	3.23	2.3
	Min.	1.10	1.37	1.00	1.50	1.67	1.40	1.37	1.67	1.1
	Av.	2.00	1.63	2.00	2.20	2.56	1.87	1.63	2.23	1.8
Water absorption,[d] 48-hr. immersion, dry basis, percent		5.1	3.6	10.6	/	5.1	11.9	/	/	3.
Hardness,[f] Rockwell "H"		83	85	74	84	87	81	96	89	9
Specific gravity[e]		1.497	1.426	1.47	1.480	1.429	1.42	1.479	1.44	1.44
Bulk factor		4.64	6.35	3.88	4.35	4.67	4.64	4.67	4.27	5.8
Molding quality[b]		F-G	F-G	P-F	F-G	G	F-G	F-G	F-G	

[a] Molding pressure, 4500 p.s.i.; curing temperature, 160 to 165° C.
[b] A.S.T.M. D 48-39.
[c] A.S.T.M. D 256-38; unnotched specimens were used instead of notched specimens
[d] A.S.T.M. D 48-39, 3-in. disks, 0.2-in. thick used. Values reported do not include loss in water between conditioned and reconditioned weight as now required according to
[e] Disks disintegrated during immersion in water.

LDING COMPOSITIONS AND MOLDED PRODUCTS[a] FROM UNPLASTICIZED AND PLASTICIZED FIBERS OF AGRICULTURAL RESIDUES

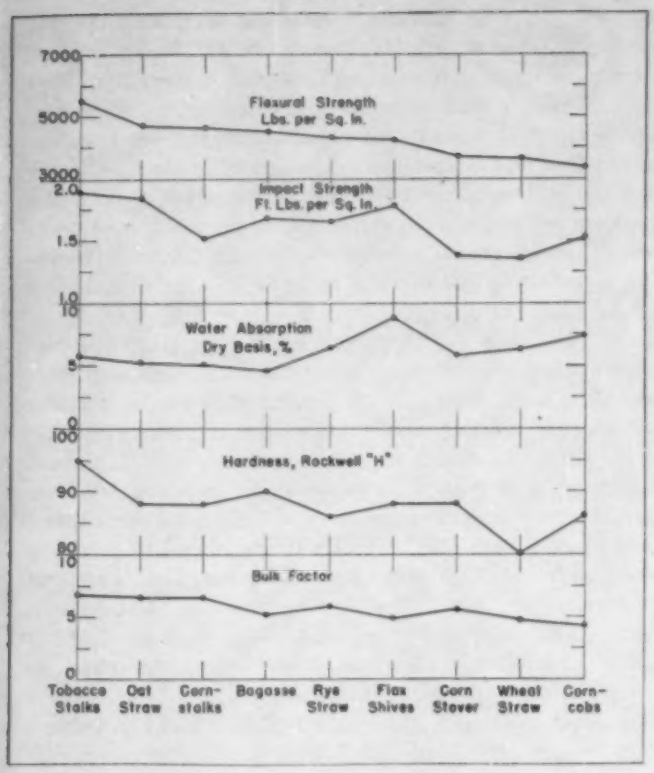
	ACID-HYDROLYZED FIBER							ANILINE-DIGESTED FIBER									
	Wheat straw	*Oat straw*	*Rye straw*	*Flax shives*	*Bagasse*	*Tobacco stalks*	*Oat hull residues*	*Corn stover*	*Corn stalks*	*Corn-cobs*	*Wheat straw*	*Oat straw*	*Rye straw*	*Flax shives*	*Bagasse*	*Tobacco stalks*	*Corn stover*	*Corn stalks*
	4190	4970	5640	3250	5140	4810	1260	2900	4870	1260	4030	6820	4680	4440	4560	8270	8030	6080
	2890	4810	5170	1670	3790	3780	920	2650	1660	1140	3490	6280	4630	3670	3860	6670	6760	4900
	3510	4890	5330	2400	4240	4240	1100	2810	3260	1220	3820	6610	4660	4060	4140	7810	7560	5470
	1.70	2.33	2.00	1.67	1.97	2.70	0.43	0.77	1.97	..	1.47	1.63	2.50	2.64	2.53	2.67	2.90	3.00
	1.37	2.03	1.77	1.20	0.90	2.13	0.26	0.63	0.47	..	0.67	1.27	1.67	1.70	0.91	1.67	2.37	2.80
	1.87	2.16	1.90	1.43	1.30	2.40	0.35	0.70	0.97	..	1.20	1.37	1.97	2.16	1.53	2.13	2.64	2.90
	19.5	16.1	14.5	28.0	15.6	13.3	[c]	14.5	19.2	18.4	5.9	3.9	3.48	1.77	2.25	3.43	32.0	30.6
	74	83	89	55	84	88	18	86	82	88	87	97	97	94	98	>100	95	94
	1.391	1.390	1.388	1.358	1.382	1.390	1.240	1.338	1.308	1.279	1.349	1.357	1.345	1.319	1.347	1.381	1.436	1.433
	8.8	11.0	10.4	7.4	7.35	11.1	3.17	5.68	5.42	4.85	5.64	13.4	9.45	5.14	5.31	14.6	18.3	18.7
	P	P	P-F	P	P	P	P	P	F	F	P	P-F	G	P-F	F	P-F	F	P	P
	FIBER + 8 PERCENT ANILINE + 8 PERCENT FURFURAL							ANILINE-DIGESTED FIBER + 8 PERCENT ANILINE + 8 PERCENT FURFURAL									ALKALINE-I
	4870	5860	5730	..	5670	7240	3330	2780	2550	970	3480	4380	2960	5190	4070	5300	6600	8540
	4290	5250	5530	..	4900	6850	2830	2150	2220	730	3140	3650	1750	4360	3300	4980	5800	4360
	4510	5560	5610	..	5290	7110	3130	2470	2390	860	3310	3960	2530	4780	3690	5160	6200	6870
	2.26	2.67	2.43	..	2.33	3.20	1.93	1.17	0.84	1.17	0.33	2.16	1.17	1.77	1.23	2.80	2.40	3.80
	0.70	0.97	1.17	..	1.30	1.33	0.57	0.33	0.30	0.23	0.30	0.70	0.30	1.03	0.60	1.13	1.70	1.80
	1.43	2.10	1.80	..	1.97	2.00	1.23	0.77	0.60	0.60	0.33	1.30	0.70	1.43	1.00	1.80	1.93	2.43
	1.96	2.94	3.89	4.0	3.1	4.5	6.0	1.28	0.93	1.14	0.42	1.4	1.30	0.34	0.37	1.97	18.3	12.6
	90	92	90	93	95	97	76	94	97	99	91	93	94	95	96	99	86	97
	1.453	1.412	1.405	1.340	1.430	1.422	1.308	1.336	1.342	1.354	1.363	1.360	1.370	1.414	1.349	1.394	1.450	1.439
	4.20	4.79	5.21	4.44	4.79	4.76	3.22	3.67	3.89	5.03	3.65	4.58	4.2	3.84	3.51	5.64	8.31	9.8
	F-G	G	G	F-G	F-G	F	P	E	E	G	G	E	G-E	G-E	G-E	G	P-F	F-G
	FIBER + 8 PERCENT PHENOL + 8 PERCENT FURFURAL							ANILINE-DIGESTED FIBER + 8 PERCENT PHENOL + 8 PERCENT FURFURAL									ALKALINE-I
	3580	4580	3590	4600	3260	5150	3220	1950	2890	2800	3390	3130	..	4750	4060	4990	4420	5860
	3010	4370	3300	4150	3210	4890	2650	1240	2130	1250	2390	2660	..	3260	3910	2670	3730	3430
	3210	4510	3450	4370	3230	5020	3000	1690	2380	2130	2890	2800	..	4000	3990	4430	4000	4510
	2.46	3.33	1.83	3.93	2.00	1.83	1.50	0.70	0.80	1.17	1.03	1.77	..	1.67	1.27	2.16	2.50	2.36
	0.63	2.00	0.87	1.17	1.53	1.17	0.60	0.33	0.33	0.43	0.70	0.63	..	1.50	0.77	0.77	1.60	1.30
	1.60	2.50	1.43	1.97	1.73	1.43	1.10	0.53	0.70	0.84	0.80	1.33	..	1.57	1.00	1.47	2.06	1.73
	6.3	3.8	4.9	7.0	4.06	7.77	13.5	0.66	0.62	0.61	0.50	1.08	0.76	0.45	0.54	2.28	33	20.8
	72	82	68	83	77	87	73	93	94	98	85	90	96	92	91	99	75	78
	1.418	1.399	1.413	..	1.427	1.416	1.340	1.328	1.330	1.340	1.358	1.347	1.344	1.355	1.355	1.385	1.412	1.434
	3.91	4.22	4.31	4.26	3.96	5.32	3.78	3.00	3.08	3.09	3.15	3.42	3.3	3.92	3.18	4.21	5.60	7.01
	F-G	G	G	F-G	F-G	F	P	E	E	G-E	G	E	G-E	G-E	G-E	G-E	P-F	P-F
	YDROLYZED FIBER + 8 PERCENT FURFURAL							ANILINE-DIGESTED FIBER + 8 PERCENT FURFURAL									ALKALINE-I
	4680	5370	4560	5850	5010	6430	3620	3100	2490	3520	3620	3070	3000	4020	4395	5510	6960	..
	4420	4430	4510	5250	4170	5960	2800	1680	1800	1110	2940	1890	1370	4010	3380	3600	6300	..
	4580	5000	4540	5520	4690	6200	3250	2320	2180	2490	3340	2710	2230	4015	3890	4340	6630	..
	3.20	3.70	2.30	1.90	3.23	2.33	1.53	1.07	0.94	1.17	1.60	1.73	1.33	1.93	1.53	3.00	2.67	..
	1.50	1.67	1.40	1.27	1.67	1.10	0.50	0.23	0.53	0.50	0.30	0.70	0.57	1.43	0.53	0.87	1.87	..
	2.20	2.56	1.87	1.63	2.23	1.87	1.00	0.50	0.73	0.84	1.03	1.33	1.00	1.60	1.03	1.80	2.16	..
	[f]	5.1	11.9	[f]	[f]	3.7	16.4	1.48	0.38	1.29	0.85	1.28	0.88	[f]	0.54	1.63	[f]	20.0
	84	87	81	96	89	94	64	96	97	102	92	93	94	93	93	99	87	61
	1.480	1.429	1.42	1.479	1.44	1.446	1.378	1.356	1.372	1.371	1.400	1.386	1.378	1.435	1.410	1.414	1.48	1.446
	4.35	4.67	4.64	4.67	4.27	5.83	3.56	3.55	3.44	3.35	3.70	4.24	3.76	3.73	3.63	5.10	6.62	8.09
	F-G	G	F-G	F-G	F-G	F	P	E	E	E	G	E	G-E	G-E	G-E	G	P-F	P-F

nditioned weight as now required according to A.S.T.M. D 570–40 T.

[f] "H" scale: 1/8-in. ball penetrator and 60-kg. load.
[c] A.S.T.M. D 392–38.
[a] By visual observation of molded ash trays, bars, and disks. P = poo
[f] Disks were not uniformly cured and could not be used for absorption
[b] Result of a single test; other disks were not uniformly cured.

Corn slover	Corn stalks	Corn-cobs	Wheat straw	Oat straw	Rye straw	Flax shives	Ba-gasse	To-bacco stalks
ALKALINE-FURFURAL-DIGESTED FIBER								
8030	6080	1460	5070	3680	4040	3160	6020	2800
6760	4900	1380	4410	2540	2940	2600	3860	2460
7560	5470	1410	4830	3190	3620	2850	4910	2520
2.90	3.00	0.73	2.50	2.37	2.70	2.16	2.94	2.26
2.37	2.80	0.60	2.00	2.13	2.16	1.97	2.43	1.80
2.64	2.90	0.67	2.26	2.30	2.47	2.03	2.70	1.97
32.0	30.6	•	95.3	65.2	47.1	•	25	•
95	94	61	88	97	92	..	95	86
1.436	1.433	1.39	1.36	1.40	1.413	1.366	1.423	1.408
18.3	18.7	4.61	13.6	13.1	14.0	9.78	17.8	9.47
P	P	P	P	P	P	P	P	P
ALKALINE-FURFURAL-DIGESTED FIBER + 8 PERCENT ANILINE + 8 PERCENT FURFURAL								
6600	8540	4390	6210	6920	7410	7020	8590	6760
5800	4360	3980	5980	6220	3030	6060	6880	5320
6200	6870	4190	6100	6570	4330	6540	7740	6040
2.40	3.80	3.84	2.84	3.26	1.43	2.67	3.13	2.96
1.70	1.80	1.20	1.37	2.00	1.00	1.97	2.20	1.80
1.93	2.43	2.20	2.03	2.46	1.20	2.37	2.67	2.37
18.3	12.6	i	10.6	12.9	9.4	3.90	8.7	4.8[1]
86	97	87	92	94	85	93	94	91
1.450	1.439	1.49	1.49	1.437	1.440	1.420	1.432	1.48
8.31	9.8	3.56	6.4	8.49	7.21	5.51	7.76	6.38
P-F	F-G	F	P-F	P-F	F-G	P-F	P-F	P-F
ALKALINE-FURFURAL-DIGESTED FIBER + 8 PERCENT PHENOL + 8 PERCENT FURFURAL								
4420	5830	3300	5450	5380	5980	5610	4380	6930
3730	3430	2870	5310	5050	1710	5360	4330	6430
4000	4510	3080	5380	5210	3780	5490	4360	6710
2.50	2.36	2.50	2.40	2.70	..	2.56	2.10	2.80
1.60	1.30	0.70	1.83	1.67	..	1.40	1.67	1.47
2.06	1.73	1.83	2.20	2.26	0.80	2.10	1.90	2.00
33	20.8	10.8	17.8	25.3	i	i.	i	12.3
75	78	73	84	83	54	92	75	91
1.412	1.434	1.40	1.43	1.40	1.415	1.369	1.406	1.42
5.60	7.01	3.46	5.80	5.84	6.4	5.27	6.27	5.79
P-F	P-F	F	P-F	P-F	F	P-F	P-F	P-F
ALKALINE-FURFURAL-DIGESTED FIBER + 8 PERCENT FURFURAL								
6900	..	4610	6870	5750	6260	5390	6690	6660
6300	..	3660	6520	4350	5220	4890	6500	5350
6630	..	4140	6700	5050	5740	5080	6600	6010
2.67	..	3.26	2.77	4.64	2.87	2.20	2.64	2.46
1.87	..	0.90	1.70	1.97	1.83	1.73	1.77	1.63
2.16	..	1.93	2.23	2.73	2.60	1.93	2.30	2.06
i	20.0	i	i	i	i	i	i	i
87	61	82	92	90	87	94	87	89
1.48	1.446	1.51	1.43	1.41	1.395	1.386	1.420	1.41
6.62	8.09	3.61	5.7	6.97	6.28	5.18	7.54	5.77
P-F	P-F	F	P-F	P-F	F-G	P-F	P-F	P-F

disks. P = poor, F = fair, G = good and E = excellent.
d for absorption tests.
y cured.



2—*These averages of some of the physical properties for certain compositions and molded products that are produced from agricultural residues from water, acid and aniline hydrolyses show a possible trend in sequence*

impact and flexural tests were cured 7 min., while disks 3 in. in diameter and 0.2 in. thick for specific gravity and absorption determinations were cured 5 minutes. Ash trays, 3.5 in. in diameter, $^{13}/_{16}$ in. deep and $^{1}/_{8}$ in. thick, used for the visual estimation of relative plastic flow, were cured 4 minutes.

Physical tests

Standard A.S.T.M. methods (3, 4, 5) were used in obtaining physical data on the molding compositions and on the molded specimens. A special 350-lb. testing machine (6) was used for all flexural tests. Broken halves from the flexural tests provided additional specimens for unnotched impact tests by the Izod method (4). Hardness was determined on a Rockwell tester using the "H" scale ($^{1}/_{8}$-in. ball penetrator and 60-kg. load). Plastic flow was estimated by appearance of the ash tray as to degree of cure, uniformity of color and sharpness of profile. The physical characteristics of the 148 individual compositions and of their molded products are presented in Table I and Figs. 1 and 2.

Discussion

The data presented in this report, although extensive, are still too limited to serve for critical evaluation of the various plant residues as raw materials for plastic molding compositions. While the methods and technique employed were those found suitable for bagasse (13, 14), they are not necessarily optima for the other fibrous residues. However, certain results and observations are considered of sufficient interest and importance to discuss briefly at this time.

The figures for lignin content of water-cooked and acid-hydrolyzed materials are higher than would be expected from the lignin content of the original material and the loss of non-

TABLE II.—PARTIAL ANALYSES OF RAW AND COOKED AGRICULTURAL RESIDUES USED IN THE PREPARATION OF EXPERIMENTAL PLASTIC MOLDING COMPOSITIONS. ALL DATA ARE PRESENTED ON OVEN-DRY BASIS

Residue	Raw fiber				Cooked with water				Cooked with acid				Cooked with aniline				Cooked with alkali-furfural			
	Ash	Lignin[a]	Pentosans[b]	Extractives[c]	Yield[d]	Ash	Lignin[a]	Pentosans[b]	Extractives[c]	Yield[d]	Ash	Lignin[a]	Pentosans[b]	Extractives[c]	Yield[d]	Ash	Lignin[a, e]	Pentosans[b, e]	Extractives[c]	Yield[d]	Ash	Lignin[a, e]	Pentosans[b, e]	Extractives[c]
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Corn stover	8.11	12.6	25.95	12.85	58.75	7.62	36.1	3.4	16.78	59.9	8.56	35.5	4.62	11.95	79.9	6.14	31.05	3.17	38.35	56.5	7.71	12.95	23.3	6.38
Cornstalks	4.11	15.65	24.36	18.68	59.8	1.94	37.05	5.09	19.21	53.0	1.97	34.08	5.82	19.27	85.5	2.07	40.0	2.71	32.32	61.5	4.15	13.5	22.5	8.04
Corncobs	1.67	12.48	38.9	1.27	59.2	1.41	31.6	5.17	17.24	59.5	1.90	24.6	10.5	18.82	85.6	0.79	48.45	2.32	18.88	59.3	3.80	5.43	38.2	2.34
Wheat straw	8.94	14.69	31.2	1.85	67.2	11.75	34.95	3.6	14.41	63.8	13.21	30.35	4.80	12.18	85.6	9.49	38.0	2.39	23.77	73.7	13.95	9.37	28.9	1.73
Oat straw	5.05	17.4	30.2	1.49	72.0	6.38	33.0	7.4	15.59	64.7	5.94	34.65	6.86	14.48	84.4	6.41	30.2	6.88	32.38	67.3	5.85	12.24	30.2	2.44
Rye straw	4.51	16.38	30.7	1.23	64.45	5.16	33.2	7.04	16.62	69.8	5.73	33.10	6.79	12.68	88.5	4.18	37.5	4.19	31.9	68.9	4.39	13.7	27.95	4.46
Flax shives	3.89	24.93	26.6	3.93	63.3	1.12	42.95	9.40	9.93	63.0	1.23	42.7	9.53	6.85	85.35	1.04	55.18	2.82	19.15	70.7	1.92	32.5	21.5	3.92
Bagasse	3.00	20.5	30.0	0.37	68.85	3.23	32.6	5.00	16.46	62.0	5.07	33.28	2.52	9.97	91.4	3.29	44.3	2.31	22.34	76.9	2.30	13.84	32.3	8.94
Tobacco stalks	10.2	13.68	19.8	9.23	61.25	5.70	33.05	5.58	13.21	58.5	3.94	34.15	6.73	11.15	66.9	5.29	29.95	4.56	30.82	57.3	6.09	22.9	17.3	1.26
Oat hull residues[f]	8.6	45.5	1.86	3.78																				

a Lignin determined by the method of Norman and Jenkins, Biochem. J. 28, 2147–59 (1934), with a 2-hr. pretreatment in 2 percent sulfuric acid.
b Pentosans determined by the method of Forest Products Laboratory, mimeograph R19, Mark W. Bray, September 1939.
c Alcohol-benzene (1:2).
d Yield based on original oven-dry fiber only.
e Lignin and pentosans determinations on alcohol-benzene (1:2) extracted materials.
f Washed residues from oat hulls hydrolyzed in the manufacture of furfural.

TABLE III.—COMPARISON OF SOME PHYSICAL PROPERTIES OF OAT STRAW COMPOSITIONS PREPARED BY FOUR METHODS OF FIBER TREATMENT.[a] (ALL COMPOSITIONS CONTAIN 8 PERCENT EACH OF ANILINE AND FURFURAL BASED ON THE WEIGHT OF THE DRY FIBER)

Property	*Water-hydro-lyzed*	*Acid-hydro-lyzed*	*Aniline-hydro-lyzed*	*Alkali-furfural hydro-lyzed*
Flexural strength, p.s.i.	5425	5560	3960	6570
Impact strength, Izod unnotched, ft.-lb./sq. in.	1.67	2.10	1.30	2.46
Moisture absorption, 48-hour immersion, dry basis, percent	1.96	2.94	1.4	12.9
Bulk factor	5.65	4.79	4.58	8.49
Molding quality (plastic flow)	Good	Good	Excellent	Poor to fair

[a] Data from Table I. All values presented are averages.

lignin material in the hydrolytic treatment. Thus, the product obtained by water cooking or acid hydrolysis of corn stover amounts to about 59 percent of the original material. The undestroyed lignin, amounting to 12.6 percent in the original material, should constitute about 21 percent of the residual material. Instead, the values for lignin are 36.1 percent in one case, and 35.5 percent in the other. Similar results were reported in 1939 in studies on acid-hydrolyzed bagasse (14). It is thought that this anomaly is due to the formation of condensation or polymerization products which are insoluble in the reagents used for the separation of cellulose and other carbohydrates from the lignin and are, therefore, weighed along with the lignin.

Compositions from water-hydrolyzed and acid-hydrolyzed fibers had, in general, very similar physical properties while those from aniline-hydrolyzed fibers were noticeably superior in bulk factor (ratio of density of molded product to apparent density of powder), plastic flow and resistance to water absorption, but lower in flexural and impact strengths. Compositions from alkaline-furfural-digested fiber had greater flexural and impact values, but were decidedly inferior in bulk factor, plastic flow and resistance to water absorption. The alkali-furfural compositions tended to adhere to the molds. Comparison of some of the physical properties of oat straw compositions prepared by the four types of digestions is shown in Table III.

Attempts to evaluate plastic flow by means of a Rossi-Peakes (Bakelite-Olsen) flow tester gave erratic results but showed clearly that the flow of these compositions was dependent to a large extent upon their moisture content and the humidity of the surrounding atmosphere, as well as upon the inherent properties of the individual compositions (24). The lack of uniformity observed during molding and testing may have been due largely to variations in atmospheric conditions, even for compositions which were stored in friction-seal containers.

It was observed, however, that aniline-hydrolyzed compositions apparently had much greater plastic flow than compositions prepared by the other methods. Aniline-cooked corn stover and cornstalk compositions became so fluid under heat and pressure that it was very difficult to mold them in the 3-piece molds. Such compositions were capable of tolerating relatively large amounts of additional fiber, with a resulting increase in strength. Addition of shredded cotton fiber, up to 100 percent of the plasticized aniline-cooked corn stover or cornstalk powders, resulted in increasing the unnotched impact strength (Izod) from 1 to 4 ft.-lb./sq. in., and the flexural strength from about 2000 p.s.i. to more than 5000 p.s.i. The fact that aniline-cooked compositions are generally deficient in flexural and impact strengths, yet have excellent flow and a tolerance for considerable fiber, indicates that the aniline-hydrolysis results in formation of resin-like products and might serve as a means for preparing such products from agricultural residues. The accumulation of resin-like materials on the digester walls on cooking with aniline tends to support this hypothesis.

Results obtained with fibers prepared by the alkali-furfural method indicate that, under the conditions used, this procedure is not satisfactory. Recent work on the isolation and recovery of soda lignin from agricultural residues has shown that pre-extraction of the residues with 1 percent caustic soda, or with water alone under heat and pressure, facilitates the subsequent recovery of lignin from the acidified soda black liquors (24). Similar treatment might have application in the alkali-furfural method to give more uniform recovery of the lignin-fiber mass without the extreme difficulty encountered in filtering and washing the precipitated lignin-pulp mixture. Further study will be required to determine the possibilities of this process.

Inspection of the physical data in Table I and Fig. 1 shows that "plasticizing" and ball milling tend to improve bulk factor, plastic flow, resistance to water absorption and general molding qualities. At the same time they reduce the flexural and impact values. These results are attributed largely to the grinding action of the ball mill. An exception is noted in the case of the alkali-furfural compositions which exhibit greater flexural strength after "plasticizing" and ball milling.

The bulk factors of these compositions are too large for practical molding purposes unless recourse is made to deep cavity molds or to the use of preforms for compacting. Differential rolls for compounding and compacting were not available at the time these compositions were prepared, but recent tests have shown that hot-milling (rolling) can reduce the bulk factor values from 12 to about 2 (24).

The average values for bulk factor, water absorption, hardness, flexural strength and resistance to impact of all of the molding compositions and molded products from each raw material, except those hydrolyzed by the alkali-furfural process, are plotted in Fig. 2. The curves show a definite trend in the sequence of the raw materials compared on the basis of the properties of their molding compositions and products with tobacco stalks apparently giving the optimum results under the conditions used in this study. It must be stated, however, that the variations in the average values for the products from all of the raw materials are fairly small. It appears, therefore, that while one raw material may have an advantage over another with a particular type of treatment, no outstanding superiority can be claimed for any one of the residues reported here. Improvements in technique and control of compacting, moisture content, the fiber and particle size, etc., will undoubtedly result in compositions and molded products of greater uniformity and improved properties.

Summary

Agricultural residues including corn stover, cornstalks, corncobs, wheat straw, oat straw, rye straw, flax shives, sugarcane bagasse, and tobacco stalks were cooked with water, dilute sulfuric acid, aniline or sodium hydroxide-furfural. Hydrolyzed oat hull residues from commercial furfural manufacture were also (*Please turn to page 198*)

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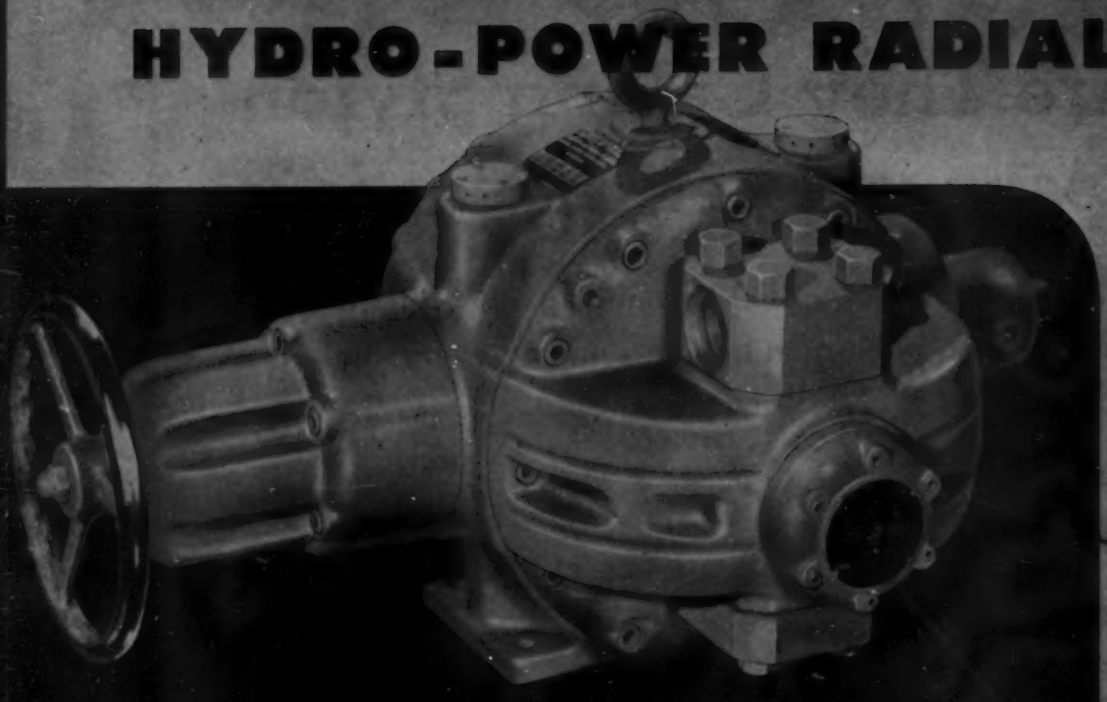

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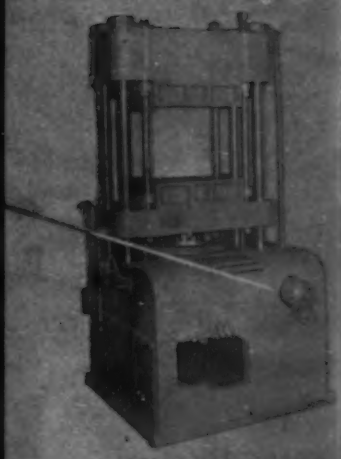

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TECHNICAL BRIEFS

Abstracts of articles on plastics in the world's scientific and engineering literature relating to properties and testing methods, or indicating significant trends and developments.

Engineering

DERMATITIS FROM SYNTHETIC RESINS AND PLASTICS. British Plastics *16*, 256 (June 1944). It is reported that the use of certain maize oil preparations, which contain linoleic and linolenic acids in a combined form, as ointments for external use and in capsules for taking by mouth to make up for the deficiency of these unsaturated fatty acids in the diet cures dermatitis resulting from contact with organic plastic materials. Four troublesome cases of dermatitis in one laboratory were cured in one week while the sufferers continued to work with the irritants.

SANDWICH CONSTRUCTION. N. J. Hoff and S. E. Mautner. Aeronautical Eng. Rev. *3*, 29–43, 63 (Aug. 1944). The characteristic feature of sandwich construction is the use of multilayer skin consisting of high-strength faces and a low-weight core. The material of the faces may be plywood, laminated paper, or aluminum alloy; that of the core, cork, balsa wood, or synthetic material. This skin is very stable and permits the building of monocoques without stiffeners. The results of strength tests with the sandwich skin loaded in tension, torsion, and bending are reported, and the manufacturing procedure of a sandwich-type aileron is explained in some detail with photographs.

THE CLEANING OF PLASTICS. E. E. Halls. Plastics (London) *8*, 305–14, 369–83 (July, Aug. 1944). The common surface contaminants of finished plastic articles are oils and greases, ink, marking varnishes or lacquers, dust and soldering fluxes. To choose solvents for cleaning, the type of plastic and the type of contaminant must be considered. The common solvents used for this purpose include 1) paraffin oils, 2) petroleum solvents, 3) coal tar solvents, 4) chlorinated hydrocarbons, 5) lacquer thinners, 6) turpentines, 7) alcohols, and 8) esters and ketones. The ideal solvent has the following properties: 1) readily obtainable, easy to handle and inexpensive; 2) simple in application and easy to remove; 3) with effective solvent action upon the contamination that is to be removed; 4) absence of solvent action upon the plastic treated; 5) minimum of absorption by the plastic treated; 6) devoid of any tendency to leave a residual film; 7) devoid of any tendency to leave the surfaces treated electrically weak; 8) free from fire hazard; 9) free from toxicity and health hazard; 10) optimum volatility; 11) devoid of objectionable odor. No solvent can fully satisfy all these requirements. The composition and properties of many specific solvents are listed and discussed. The effects of various solvents on the common types of plastic moldings, lubricating compositions, machining techniques and large-scale cleaning are discussed.

DELIGNIFIED IMPREGNATED WOOD. F. Luce. Mechanical Eng. *66*, 654–5, 657 (Oct. 1944). Wood veneers are treated to remove the lignin by a process similar to paper making except the procedure is modified so that the wood structure is left intact. The veneers are then impregnated with a synthetic resin by immersing in a bath of the resin for a few minutes. After drying, the veneers are ready for fabrication. The product is extremely flexible, has little springback, is tough and is resistant to splitting. Sheets, bends and complex shapes may be molded at pressures as low as 25 p.s.i. The molded pieces have good dimensional stability, low density and high strength. This process serves to eliminate the one great objection to wood: namely, swelling and shrinking. Other advantages are an increase in uniformity of the strength properties and an increase in ease of fabrication. The treatment has been successful for veneers up to ⅛-in. in thickness. The most suitable woods are birch, mahogany, western hemlock, Douglas fir and spruce.

Chemistry

A SIMPLE THEORY OF THE VISCOSITY OF MACROMOLECULAR SOLUTIONS IN EXTREME DILUTION ON THE BASIS OF VARIABLE CONVOLUTION SHAPE. J. J. Hermans. Kolloid-Z. *106*, 22–9 (1944); Chem. Abstracts *38*, 3533–4 (July 20, 1944). The viscosities of solutions of paraffin, polystyrene, cellulose, cellulose nitrate, cellulose acetate, cellulose triacetate and methyl cellulose in benzene, Schweizer's reagent, acetone, butyl acetate, chloroform, *m*-cresol and water were determined. The macromolecules are considered to be flexible coils which are deformed during flow. The product of the shearing modulus calculated from the deformation by the Kuhn statistical method, and the relaxation time required for the molecules to return to their original shapes defines the contribution of the macromolecules to the viscosity. The final viscosity formula contains a factor expressing the degree of stretch for coiled molecules, which makes it possible to determine the relation between the degree of stretch, the solvent and the temperature. The theory agrees with the Staudinger viscosity concept.

METHODS OF STRUCTURAL ANALYSIS OF MACROMOLECULES. R. Lepsius. Kunststoffe, *33*, No. 5, 133–8 (1943); Chem. Abstracts *38*, 3183 (July 10, 1944). The use of x-ray methods, Raman spectroscopy, ultramicroscopy streaming birefringence, polarized light, electron microscopy and ultrasonic waves for investigating the structure of macromolecules is discussed.

HEAT OF ADSORPTION OF ACETONE BY FIBERS AND FILMS OF CELLULOSE NITRATE. E. Calvet. Compt. rend. *214*, 716–18 (1942); Chem. Abstracts *38*, 3888 (Aug. 10, 1944). The heats of adsorption of acetone by fibers and films of two cellulose nitrates containing 11.5 and 14 percent nitrogen were measured. At the beginning of the adsorption the heat evolved is about 80 calories per gram of acetone and is independent of the degree of nitration. The curves show a maximum evolution of heat with adsorption of 6 mols of acetone per glucose unit; the values are 24,700 calories per gram for cellulose nitrate of 11.5 percent nitrogen content and 18,600 calories per gram for that of 14 percent nitrogen content. The curves drop sharply beyond this concentration. The heats of solution (all positive) are as follows: for fibers, 5750 cal./g. for 14 percent nitrogen content and 4500 cal./g. for 11.5 percent nitrogen content; for films, 4280 cal./g. for 14 percent nitrogen content and 3850 cal./g. for 11.5 percent nitrogen content.

Properties

DIRECTIONAL THERMAL EXPANSION OF LAMINATED SYNTHETIC RESINS. R. Vieweg and W. Schneider. Kunststoffe *32*, 295–7 (1942); Chem. Abstracts *38*, 3747 (July 20, 1944). The coefficients of thermal expansion of paper-base and fabric-base phenolic laminates were measured by an optical method to determine the directional relationship. The coefficient of expansion for the direction perpendicular to the laminations is greater than that for the

direction parallel to the plane of the laminations. The volume expansion is not equal to 3 times the linear expansion for these laminates. For most materials the volume expansion is equal to 3 times the linear expansion.

THE BEHAVIOR OF POLYMERS AND COPOLYMERS. R. F. Boyer. Canadian Chem. and Process Ind. *28*, 528–30 (Aug. 1944). For a given polymer once a certain chain length is reached, mechanical properties become relatively independent of further increase in chain length. Aside from solution viscosity and melt flow characteristics, such properties as refractive index, softening point and tensile strength are largely independent of molecular weight and molecular weight distribution for commercial polymers. A measurement of the coefficient of linear thermal expansion is a valuable means for studying the behavior of polymers and is even more significant for studying the copolymers. The second order transition point obtained in such measurements correlates well with molding conditions, cold flow, low temperature brittleness, electrical behavior and moisture vapor transmission. In general, the more polar the nature of the side group on the hydrocarbon chain, the higher will be the transition temperature. As the styrene content of butadiene-styrene copolymers is increased from 0 to 100 percent, the second order transition point increases from –90 to 80° C. Increasing the amount of cross-linking agent from 0 to 25 percent in cross-linked styrene copolymers, increases the transition point from 80 to 130° C. The relations between transition point, melting point, softening point, solubility and composition of vinylidene chloride-vinyl chloride copolymers are discussed in detail.

THE EFFECT OF HIGH RELATIVE HUMIDITIES IN PRODUCING CHANGES IN DIMENSIONS OF PLASTICS. A. C. Titus. Plastics & Resins Ind. *3*, 12–14 (Aug. 1944). The results of measurements made on cotton, asbestos and glass fabric laminated phenolic plastics during exposure to various humidities show that the asbestos and glass-fabric-filled materials are more dimensionally stable than the cotton-fabric-filled material.

DIELECTRIC MEASUREMENT OF THE PLASTICIZATION OF POLYVINYL CHLORIDE. F. Würstlin. Kolloid-Z. *105*, 9–16 (1943); Chem. Abstracts *38*, 4167–8 (Aug. 10, 1944). Polyvinyl chloride exhibits in a certain temperature region an anomalous dispersion of the dielectric constant and a maximum in the dielectric loss factor. As plasticizer is added, this region shifts to a lower temperature. Plasticizers may be arranged in the order of their ability to lower the viscosity of polyvinyl chloride by comparisons of their ability to shift the maximum in the dielectric loss factor. Low viscosity plasticizers lower the viscosity of polyvinyl chloride more than high viscosity plasticizers. The method is applicable to polyvinyl acetate since it also has a decided anomalous dispersion region. Conversely, the method is not applicable to polystyrene, polyisobutylene and polymethyl methacrylate because they do not have a decided anomalous dispersion region.

TESTING THE SUITABILITY OF PACKAGING MATERIALS AND PACKAGES (AS CONTAINERS) FOR COLD-STORAGE GOODS. II. G. Kaess. Papier-Fabr.-Wochbl. Papierfabr. *1943*, 203–15; Chem. Abstracts *38*, 4437 (Aug. 20, 1944). The moisture vapor, air and gas permeabilities, water resistance, fat penetration, folding endurance, resistance to fruit acids and wet and dry bursting strengths of a large number of packaging materials were determined. A large amount of data is presented and discussed in detail. Twenty-two references.

PERMEATION OF GASES THROUGH VARIOUS ORGANIC FILMS AND ITS RELATION TO THEIR PERMEABILITY TO WATER. F. H. Müller. Kolloid-Z. *100*, 355–61 (1942); Chem. Abstracts *38*, 4177–8 (Aug. 20, 1944). The diffusion of helium, argon, krypton, xenon, neon, hydrogen, oxygen and water vapor through films of polystyrene, polyvinyl chloride and cellulose triacetate was measured. The diffusion coefficient decreases as the molecular weight of the gas increases. Cellulose triacetate is the most permeable to water vapor, polystyrene is next and polyvinyl chloride is the least permeable. The permeability of water through films of polystyrene and polyvinyl chloride increases slightly with an increase in temperature; for films of cellulose triacetate the permeability decreases rapidly with every increase in the temperature.

Testing

A PHOTO-ELECTRIC PHOTOMETER FOR MEASURING THE LIGHT SCATTERED BY THE SURFACE OF A TRANSPARENT MATERIAL. J. M. Sowerby. J. Sci. Instruments *21*, 42–5 (March 1944). A photometer for measuring the light scattered at 45° from the surface of a transparent plastic which has been abraded is described. The abraded portion is illuminated with a beam of light, and the scattered light falls on a vacuum photocell which is coupled to an amplifier. The amplifier drives a turning eye and the adjustable element is a calibrated potentiometer.

PRELIMINARY STUDIES ON A DROP-BALL IMPACT MACHINE. G. Lubin and R. R. Winans. A.S.T.M. Bulletin No 128, 13–18 (May 1944). A machine for making drop-ball impact tests is described. The usual notched Izod type specimens are used. Single-blow, repeated-blow and increased-blow tests were made with seven laminated phenolics, eight molded phenolics and six thermoplastics. The usual Izod impact strength values were determined for the same materials. It appears that the drop-ball impact test method is more applicable and more accurate than the Izod excess-swing pendulum for impact strength determinations. Most of the errors inherent in the Izod machine are eliminated or reduced to a minimum using the drop-ball method. The impact fatigue strength of plastics as determined by the latter method is a reliable indication of the actual working stress of the material. The fatigue curves also provide a convenient method of predicting the behavior of the plastic materials which are in service.

DETERMINATION OF CHLORINE IN CHLORINATED RUBBER. R. Fusco. Ann. chim. applicata *32*, 360–2 (1942); Chem. Abstracts *38*, 3869–70 (July 20, 1944). The Carius method is not suitable for determining chlorine in chlorinated rubber since the high temperatures required for decomposition tend to cause the tubes to explode. Good results can be obtained by burning the chlorinated rubber in a current of moist oxygen, hydrolizing the chlorinated hydrocarbons formed with platinized pumice to hydrogen chloride, and collecting the hydrogen chloride in a solution of sodium hydroxide.

MICROSCOPIC INVESTIGATIONS OF SYNTHETIC-RESIN MOLDING COMPOUNDS. W. Weigel and W. Grosse. Blätter Untersuch.-u. Forsch.-Instrument *15*, 37–40 (1941); Chem. Abstracts *38*, 4338 (Aug. 20, 1944). Finely powdered molding material is sprinkled on a glass slide from an 0.5 mm. mesh sieve and examined under a microscope. The resin and filler may be separated by putting a drop of ethyl alcohol or acetone on the powder. A polished section of a molded piece shows a characteristic appearance of the filler under the microscope. Woodflour is stained red by a solution of phloroglucinol in 20 percent hydrochloric acid.

ANALYSIS OF CELLULOSE DERIVATIVES. C. J. Malm, L. B. Genung, R. F. Williams and M. A. Pile. Ind. Eng. Chem. Anal. Ed. *16*, 501–4 (Aug. 1944). A method for the analysis of total acyl in cellulose esters of organic acids is presented in which the sample is saponified in solution. This method over-

comes some of the difficulties encountered in the commonly used heterogeneous saponification methods in that it is independent of the condition of the samples, can be run in a shorter elapsed time, and is a little more accurate. It does, however, involve somewhat more complicated manipulation. This method has been applied to solvent-soluble cellulose acetates (containing from 15 to 44.4 percent acetyl), cellulose acetate propionates and acetate butyrates, and cellulose propionates and butyrates up to and including tributyrates. These cellulose esters were divided into four groups based on composition and solubility. Variations are recommended for each group such that the sample is dissolved in a suitable solvent, and alkali and water are added alternately to maintain a solvent system until saponification is nearly complete. The regenerated cellulose is then in a finely divided form and does not interfere with the completion of the reaction or the back-titration. The effects of time and temperature of saponification and time and alkali concentration were studied; optimum conditions established.

Synthetic Rubber

THE DEPENDENCE OF THE REBOUND ELASTICITY OF RUBBER-LIKE ELASTIC MATERIALS ON THE TEMPERATURE. P. Stöcklin. Kautschuk *18*, 151–8 (1942); Chem. Abstracts *38*, 3871 (July 20, 1944). The rebound resilience of various vulcanized synthetic rubbers, plasticized polyvinyl chloride and ethyl acrylate polymers was determined with a Schob pendulum machine at –50 to 100° C. The rebound resilience-temperature curves for all these materials showed the same trend. As the temperature decreases, the height of rebound increases to a maximum, then to a minimum, and then increases again.

ELECTRON MICROSCOPE STUDIES OF NATURAL AND SYNTHETIC RUBBER FIBRES. C. E. Hall, E. A. Hauser, D. S. leBeau, F. O. Schmitt and P. Talalay. Ind. Eng. Chem. *36*, 634–40 (July 1944). Two characteristic types of fibre structure were observed in electron microscopic studies of fibres and films of Hevea, guayule and Cryptostegia natural rubbers and Buna S and neoprene synthetic rubbers. One type has numerous "fluid" nodules and the other consists of branched networks of beaded fibre. These two types are characteristic of the sol and the gel fractions, respectively. Cold vulcanization in solution produces structures resembling those of a gel. Certain tentative suggestions as to the nature of carbon black reinforcement are offered on the basis of the electron microscope observations of vulcanized and unvulcanized rubber incorporating carbon blacks.

RELATION OF STRUCTURAL FEATURES TO PHYSICAL PROPERTIES — OF BUNA S. A. R. Kemp and W. G. Straitiff. Ind. Eng. Chem. *36*, 707–15 (Aug 1944). The nonsymmetry in the chain structure of Buna S hydrocarbon is discussed in relation to the prevention of crystallization and the impeding of cross linking during vulcanization. This lack of chain symmetry is put forward to account for the poor quality of Buna S vulcanizates in comparison with corresponding vulcanizates prepared from natural rubber. Fractionation data on a regular benzene-soluble crude Buna S indicates the presence of an objectionable broad range of polymer sizes. It is shown that the lowest-molecular-weight polymer fractions in Buna S are not chemically bound in the vulcanizate but remain soluble in chloroform. By removing most of this low polymer from Buna S, the chloroform extract of its vulcanizate decreases accordingly. Vulcanizates were prepared from high- and low-molecular-weight fractions of Buna S. The high fractions were tough, dry and difficult to handle on the mill; the lower-molecular-weight fractions were soft and sticky. The tensile strength of vulcanizates from the high fraction was somewhat greater than that of the whole polymer, but the modulus was considerably increased. For the low-molecular-weight polymer both tensile and modulus values were much lower. Vulcanizates prepared from mixtures of natural rubber and gutta-percha hydrocarbons show lower strength than either of the hydrocarbons tested separately.

THE CARBON SPECTRUM FOR THE RUBBER COMPOUNDER. C. W. Sweitzer and W. C. Goodrich. Rubber Age *55*, 469-78 (Aug. 1944). Through the evaluation of three basic carbon properties, pH, surface and structure, and by knowledge of the effects of these properties on rubber, means for predicting fairly closely the behavior of any carbon in Hevea and GR-S rubber are available. The pH, as measured on a carbon slurry, provides an index to rate of cure. Surface, as evaluated by simple mineral oil color and tinting strength tests in correlation with fineness values for a limited number of standard carbons, provides an index to reinforcement, tensile, energy and rebound properties in rubber. Structure, conveniently measured by an oil absorption test in conjunction with known surface area value, provides the index to the anomalies in modulus, hardness, extrusion and related properties in rubber. Electrical conductivity, shown to be a derived rather than a basic property, correlates with electrical conductivity in rubber, provided 2 of the 3 basic carbon properties remain constant.

DETERMINATION OF RATE OF CURE OF GR-I AND NATURAL RUBBER. L. H. Cohan, M. Sohn and M. Steinberg. Ind. Eng. Chem. *16*, 562–6 (Sept. 1944). The T-50 temperature, an A.S.T.M. extension-temperature test, and the tensile ratio, tensile strength at an undercure divided by maximum tensile strength, were investigated to determine their efficacy as indexes of rate of cure of GR-I, butyl and synthetic rubbers. The T-50 temperature varies only slightly with cure time and is not satisfactory as an index of rate of cure for GR-I. Tensile ratio, on the other hand, appears to be satisfactory as an index of the rate of cure. A convenient undercure for stocks in the series having intermediate cure rates is one which gives a tensile ratio of about 0.60. Combined sulfur in GR-I varies with cure time in a manner similar to that observed for natural and GR-S rubbers.

PLANT INVESTMENT AND PRODUCTION COSTS FOR SYNTHETIC RUBBER. Chem. Ind. *55*, 379–81, 446 (Sept. 1944). This is a condensation of the report of the Office of Rubber Director on investment and operating costs of government synthetic rubber plants.

THE RUBBER INDUSTRY: NATURAL OR SYNTHETIC. H. L. Fisher. Chem. Ind. *55*, 388–92 (Sept. 1944). The methods for making the various types of synthetic rubbers are briefly described. A long list of chemicals used in the rubber industry is given. The various types of chemicals used in compounding rubbers are discussed.

INCORPORATION OF CARBON BLACK INTO GR-S LATEX. R. L. Rongone, C. B. Frost and G. H. Swart. Rubber Age *55*, 577–82 (Sept. 1944). A commercially feasible method for adding carbon black to latex was developed and tested. The black-latex mixture can be handled in essentially the same way as normal GR-S throughout the various steps of coagulation, washing, drying and baling. By incorporating black into GR-S latex, an increase in milling capacity of about 35 percent is possible. The total power required for mixing this black-rubber is at least 20 percent less than for tread stock mixed in the conventional way. Mixing temperatures are lower for latex-black stocks. Physical properties and preliminary tire tests show that carbon black incorporated with the latex produces stock equivalent in physical properties to stocks prepared by mixing carbon black into dry rubber. Considerable savings are made possible by the use of this method. The amount of dirt now present in the millrooms of the rubber manufacturing plants should be greatly reduced.

PLASTICS DIGEST

This digest includes each month the more important articles of interest to those who make or use plastics. Mail request for periodicals directly to publishers.

General

PLASTICS FOR HOUSING. British Plastics *16*, 238–42 (June 1944). This is an abstract of a report of the Plastics Committee on the application of plastics to housing. Present plastics are not suitable for structural components. The use of resin-bonded plywood and laminated wood timbers as structural components has good possibilities. Laminated and sheet plastics have properties which make them useful as paneling for walls, ceilings and floors. Molded window frames and various other frames, staircases, chimneypieces, etc., are being seriously considered. Electrical, plumbing and heating fixtures, tubing for water, electric wires and protective coatings will also utilize plastics. The report has a comprehensive list of actual and potential applications of plastics in the building industry. Copies of the Plastics Committee report, H. V. Potter, chairman, on "Plastics for Housing" is available from H. M. Stationery Office, London, England, at 1/– net.

THE CHEMICAL RAW MATERIAL POTENTIAL AND ITS RELATION TO THE TREND OF SYNTHETIC RESIN DEVELOPMENT. W. D. Scott. Chemistry and Industry *1944*, 274–8 (July 29, 1944). The raw materials needed for synthetic resin production are discussed from the viewpoint of their sources and costs. In many instances, the potentialities of the United Kingdom and the United States in this respect are compared.

MANUFACTURE OF INSULATION AND PRESSED BOARDS, ETC., FROM BAGASSE. M. P. Bhargava and A. N. Nayer. International Sugar J. *45*, 95–7 (1943). The manufacture of insulation and pressed boards from sugar cane bagasse is described. The costs of production are estimated. The sodium salt of pentachlorophenol is recommended as a preservative.

SURFACE HARDNESS OF ORGANIC GLASSES. Plastics (London) *8*, 316–19 (July 1944). This is a translation of a German article by Perkuhn in Luftfahrtforschung *20*, 297 (1943). The Zeiss Diritest machine for determining surface hardness was investigated. Three grades of methacrylate resin, cellulose acetate and a vinyl chloride-acrylate copolymer were used for the tests. The scratch hardness values obtained depend on the rate of scratching, the load applied and the temperature. Increasing the rate of scratching results in increasing the scratch hardness values; an increase in the load applied gives lower values; and an increase in temperature lowers the scratch hardness. The ratio of tensile strength to hardness is a constant for these materials at temperatures between 4 and 40° C. The ratio for methacrylate resin is 0.087, for cellulose acetate 0.113 and for vinyl chloride-acrylate copolymer 0.157.

A NEW CHEMICAL METHOD FOR RECLAIMING NYLON. Chemical Industries *55*, 376–8 (Sept. 1944). Nylon scrap, cuttings and old stockings are depolymerized by hydrolyzing in boiling sulfuric acid. The adipic acid and hexamethylenediamine formed are purified and used to make new nylon stock.

PLASTICS AND THE POTTERY AND GLASS INDUSTRIES. Plastics (London) *8*, 417–25 (Sept. 1944). The relations of the plastics industry to the pottery and glass industry are discussed. Topics include glass-fabric-plastic materials, other glass-plastic combinations, domestic ware, tiles, containers, transparent models, organic glasses, surgical instruments, glazing materials and lamp shades.

Materials

ACRYLIC RESINS. D. A. Rothrock. Canadian Chem. and Process Ind. *28*, 599–602 (Sept. 1944). The characteristics and applications of acrylic resins are reviewed. The compounds included the polymers of methyl methacrylate, ethyl methacrylate, the various isomeric butyl methacrylates, methyl acrylate, ethyl acrylate, cetyl acrylate, cyclohexylacrylate and hexyl acrylate. The properties of these resins vary considerably. The acrylates are generally softer than the corresponding methacrylates. A brief discussion of the polymerization of the monomers is included. Acrylonitrile is used widely as a copolymer with other materials. The sodium and ammonium salts of polyacrylic acid are used as thickening agents and textile sizing agents.

LIQUID PHENOLIC RESINS. E. F. Fiedler. Canadian Chem. & Process Ind. *28*, 531–3 (Aug. 1944). The production, properties and applications of liquid phenolic resins are described. These resins are prepared by refluxing phenol and formaldehyde in the presence of fixed alkaline catalysts such as calcium hydroxide, barium hydroxide, sodium carbonate or sodium hydroxide. The resin is stable for one to three months but is converted to the solid cured form by heat or catalysts. The liquid resins consist mainly of a mixture of phenol alcohols. The viscosity varies from 20 to 75,000 cps, the specific gravity from 1.13 to 1.27, the water content from 3 to 15 percent and the pH from 5 to 8. They are soluble in alcohols, esters and ketones. They are used as plywood adhesives, insulation varnishes, corrosion resisting varnish coatings, and as casting resins.

OBTAINING COUMARONE RESINS BY THERMAL POLYMERIZATION. M. A. Stepanenko and A. E. Minskaya. Coke and Chem. (U. S. S. R.) *11*, No. 5, 29–32 (1941); Chem. Abstracts *38*, 4063 (Aug. 10 1944). The styrene, indene and coumarone fractions can be thermally polymerized without the presence of sulfuric acid. Higher molecular weight polymers are produced by refluxing than by autoclaving at 220° C. and 6 to 7 atmospheres. The lower the temperature of the polymerization the higher the molecular weight of the polymer produced. The yields of polymer vary from 50 to 80 percent; the residue may be polymerized by the addition of sulfuric acid.

THE MICROSTRUCTURE OF HIGH-DENSITY PLYWOOD. W. M. Harlow. Mechanical Eng. *66*, 656–7 (Oct. 1944). The microstructure of high-density plywood was studied. High-density plywood can be successfully sectioned after treatment in hot aqueous 10 percent sodium hydroxide. Penetration of the resin is quite variable as between different samples. Usually the zone of greatest penetration is along the original surface of the veneer sheet. In such cases, the greatest compression occurs near the center of the sheet.

DICHLOROSTYRENES AND THEIR POLYMERS. J. C. Michalek and C. C. Clark. Chem. Eng. News *22*, 1559–63 (Sept. 25, 1944). The dichlorostyrenes and their polymers are described. One of the most promising hard polymers has a distortion temperature of 240 to 265° F., specific gravity of 1.40, tensile strength from 4600 to 7500 p.s.i., tensile modulus of elasticity of 500,000 to 700,000 p.s.i., flexural strength of 14,000 to 19,000 p.s.i., Izod impact strength of

1.0 to 1.5 ft.-lb./in. of notch, water absorption of 0.08 percent, excellent chemical resistance, excellent stability and good molding qualities. The dichlorostyrene may be copolymerized with many other compounds. Many of the copolymers are rubberlike. These copolymers compare favorably with GR-S. A large amount of data on the properties of the hard and rubberlike materials is given.

MECHANICAL PROPERTIES OF FILMS FROM AMYLOSE, AMYLOPECTIN AND WHOLE STARCH TRIACETATES. R. L. Whistler and G. E. Hilbert. Ind. Eng. Chem. *36*, 796–8 (Sept. 1944). Amylose and amylopectin triacetates differ greatly in film-forming ability. Amylose triacetate readily forms high-quality films having good tensile strength and pliability; amylopectin triacetate resembles whole starch triacetate in forming only weak, brittle films. Adequate plasticization of the amylose triacetate films can be accomplished by the addition of 10 to 20 percent of plasticizer of the types employed with cellulose acetates. In general, the properties of the amylose triacetate films are similar to those of cellulose triacetate films. Because of their high quality and low plasticizer requirements, amylose triacetate films appear suited to industrial uses.

VINYL ELASTIC PLASTICS. Rubber Age *55*, 479–80 (Aug. 1944). The properties of commercially-available elastic vinyl plastics are described. The tensile strength ranges from 1300 to 2500 p. s. i., elongation from 350 to 300 percent, tear resistance from 20 to 30 lb./in., specific gravity from 1.18 to 1.23, and durometer hardness *A* from 67 to 86. The materials have good electrical insulating properties and are resistant to water, oils, greases, acids, etc.

DIPOLE MOMENTS OF THE CHIEF CONSTITUENTS OF LAC AND ROSIN. G. N. Bhattacharya. Indian J. Phys. *17*, 153–61 (June 1943). The dipole moments of abietic acid, pure lac resin and soft lac resin were determined at 25° C. in dilute dioxane solutions. The values obtained are 1.35, 4.61 and 7.45 Debye units, respectively.

Molding and fabricating

PROCEDURES IN PLASTICS. MOLDING AND FABRICATING METHODS. W. V. Prince. Tool & Die J. *10*, 105 (Jan. 1944). The various methods of forming and fabricating plastics are described.

THE PRINCIPLES OF HIGH-FREQUENCY HEATING. L. Hartshorn. Chem. and Ind. *1944*, 322–5 (Sept. 9, 1944). The cause, laws, history, advantages and limitations of high-frequency heating are briefly discussed.

DETERMINATION OF COMPRESSION-TIME CURVES IN THE MOLDING OF HEAT-HARDENABLE SYNTHETIC RESINS. A. Schwittmann. Kunstoffe *34*, 1–5 (1944). An apparatus for determining compression-time curves for molding compounds is described. The material is molded in a standard die and the rate of closing of the press is recorded. The relation between the temperature, pressure, amount of material and flow properties and the compression-time characteristics was determined. The compression-time curves are useful for characterizing molding compounds. A translation of this article is published in Plastics (London) *8*, 426–32 (Sept. 1944).

DIAMOND TOOLS FOR PLASTICS. Plastics (London) *8*, 359–65 (Aug. 1944). Directions are given for machining plastics and other non-metallic materials with diamond tools. In many cases these tools have a much longer life than other types of hard machine tools.

Applications

LEATHER-RESINOID AND THIOKOL-AZ. A. Colin-Russ. India-Rubber J. *106*, 507–9 (May 6, 1944). Leather resinoid-Thiokol mixtures are described. They are recommended for shoe soles.

PLASTICS IN DENTISTRY. J. Osborne. British Plastics *16*, 243–8 (June 1944). The history of the use of plastics in dentures is reviewed briefly. The manufacture of dentures from acrylic resins is described in detail and various problems encountered in the procedure are discussed. Acrylic resins are also being used for the teeth in the dentures. Acrylic resin fillings have not proven to be satisfactory to date.

LEATHER-RESINOID. A. Colin-Russ. India-Rubber J. *106*, 505–7 (May 6, 1944). The nature and properties of Leather-resinoid, a term applied to various products derived from leather by partial acid hydrolysis and condensation with aldehydes, are described. The range of products can be increased by incorporating synthetic resins, plastics and rubber latexes.

BUILDERS FITTINGS IN PLASTICS. H. Turnwald. British Plastics *16*, 265–70 (June 1944). This is a translation of a German article which appeared in Kunststoffe *32*, 17–20 (1942). The design of door handles, knobs, keyhole plates and clothes pegs and of dies for their compression molding is described.

CONTRIBUTIONS OF THE CHEMIST TO INSULATION RESEARCH. 67 pp. This is a report of the Committee on Chemistry, Conference on Electrical Insulation, National Research Council, for January 1943 to 1944. The individual reviews are as follows: Review of Progress in the Field of Anomalous Dispersion, by O. M. Arnold (208 references); Review of Rubber Electrical Insulation in 1943, by J. T. Blake (29 references); Insulating Paper, by W. L. Hawkins (11 references); Synthetic Plastic Electrical Insulation — 1943, by L. A. Matheson and R. F. Boyer (118 references); Review of Literature on Insulating Oils, by C. E. Trautman (30 references); and Ceramic Electrical Insulation, by H. Thurnhauer, J. W. Deaderick and A. E. Badger (38 references). Copies may be obtained from G. T. Kohman, Bell Telephone Laboratories, Murray Hill, N. J.

Coatings

PAINTS FOR PROTECTING STRUCTURES IN WATER. F. N. Speller. Gas *20*, 33–4 (June 1944). Metal underwater structures should be thoroughly cleaned and treated with a phosphate inhibitor prior to painting. The film base of a satisfactory paint would be either phenolic resin or chlorinated rubber. Baking-type phenolics are preferred. These coatings may be used as primers for bituminous coating.

LACQUER RESINS FROM MALEIC ANHYDRIDE. A. A. Blagonravova and R. S. Karlinskaya. J. Chem. Ind. (U. S. S. R.) *18*, No. 4, 25–8 and No. 11, 19–21 (1941); Chem. Abstracts *38*, 4142 (Aug. 10, 1944). The reactions of meleic anhydride with linseed, sunflower, cottonseed, tung and olive oils to form lacquer resins are described. Films of some of these resins are very resistant to water.

SYNTHETIC RESINS IN THE SURFACE-COATING INDUSTRY. C. I. Phillips. Plastics (London) *8*, 355-8 (Aug. 1944). The role of the alkyd, acrylate, styrene, nylon and alkyl sulfide resins in the protective coating industry are discussed in general.

EVALUATION OF MARINE ANTI-CONDENSATION PAINTS. C. Y. Hopkins and T. H. G. Michael. Canadian Chem. & Process Ind. *28*, 629–30 (Sept. 1944). A method for testing marine paints designed to prevent condensation of moisture on the underdecks and walls of ship cabins is described. Results obtained with eight such coatings are reported.

A REVIEW OF SOME RECENT INVESTIGATIONS BEARING ON PHENOLIC-RESIN VARNISH CHEMISTRY AND PRACTICE. H. S. Lilley. Paint Tech. *8*, 189-91 (1943). This is a review of some recent work on phenolic resin varnishes. Twenty-five references are given.

U. S. Plastics Patents

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 10 cents each

ABRASIVE. B. J. Oakes (to Minnesota Mining and Mfg. Co.). U. S. 2,357,350, September 5. An abrasive article comprising a woven fabric impregnated with a thermoplastic resin, a grit-bonding coat consisting of a heat convertible phenol-aldehyde resin in which are embedded abrasive grains.

HALOGENATED RUBBER. J. M. Coe (to Carbide and Carbon Chemicals Corp.). U. S. 2,357,383, September 5. Chlorinated rubber plasticized with glycerol borate.

FIBROUS MATERIALS. C. S. Francis, Jr. (to Sylvania Industrial Corp.). U. S. 2,357,392, September 5. A felted fibrous product prepared by forming potentially adhesive organic plastic fibers with non-adhesive plastic fibers in a perforated mold while applying suction and subjecting the mass to pressure.

MOLDED COMPOSITIONS. J. N. Kuzmick (to Raybestos-Manhattan, Inc.). U. S. 2,357,409, September 5. A molded composition of friction material comprising asbestos fibers bonded with a heat hardenable phenol-aldehyde resin and a reaction product of shellac acids and a compound of a metal such as calcium, magnesium, zinc, barium, and lead.

COATING. J. W. Clough (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,357,458, September 5. A clear coating composition comprising a cellulose derivative and the halide of an aliphatic long chain derivative of a heterocyclic nitrogen base.

CELLULOSE DERIVATIVE. A. A. Houghton and K. J. C. Luckhurst (to Imperial Chemical Industries, Ltd.). U. S. 2,357,469, September 5. Water-insoluble cellulose glycollic acid is isolated from an etherification reaction mixture containing a fibrous water soluble alkali metal salt of the acid by adding thereto a strongly ionized acid in such amounts that the fibrous condition of the cellulose derivative is unimpaired.

TEXTILES FINISHING. D. W. Light and A. D. Nute (to American Cyanamid Co.). U. S. 2,357,526, September 5. Textiles are finished by applying an aqueous emulsion of a phthalic anhydride-polyhydric alcohol resin modified with a benzoic acid derivative and an alkaline casein solution.

RESIN. G. F. D'Alelio (to General Electric Co.). U. S. 2,357,635, September 5. An acid curing thermosetting resin containing a curing agent comprising a substituted alkyl halide.

CELLULOSE DERIVATIVES. S. M. Edelstein. U. S. 2,357,731, September 5. Solutions of cellulose derivatives are formed by contacting with aqueous solutions of sodium zincate of sufficiently high concentration to cause precipitation from a previous solution in sodium zincate and diluting with water.

ADHESIVES. W. S. Niederhauser and M. W. Miller (to Resinous Products and Chemical Co.). U. S 2,357,798, September 12. A water soluble phenol-aldehyde resin composition is prepared by condensing phenol or metacresol, formaldehyde, and a water soluble inorganic sulfite.

MOLDING. G. W. Borkland. U. S. 2,357,806, September 12. A method for forming thin flat thermoplastic sheet into a cupped shape.

MOLDING COMPOSITION. E. L. Kropscott and M. J. Hunter (to Dow Chemical Co.). U. S. 2,357,833, September 12. A synthetic thermoplastic polymer plasticized with a lower alkyl ester of a saturated hydroxy fatty acid.

PLASTIC. R. H. Manley and C. D. Evans (to Secretary of Agriculture). U. S. 2,357,839, September 12. A plastic composition comprising a prolamine plasticized with a polymeric fat acid.

METAL COATING. G. A. Goessling. U. S. 2,357,950, September 12. A molding device and apparatus for producing metal-coated plastic articles.

CELLULOSE ESTERS. H. Leemann, A. Rheiner and W. Hagenbuch (to Sandoz, Ltd.). U. S. 2,357,962, September 12. Cellulose fibers are milled in a fatty acid medium under esterification conditions and formed into a sheet while in a swollen condition.

PHOTOGRAPHIC PAPER. H. R. Clark (to Eastman Kodak Co.). U. S. 2,358,056, September 12. A photographic paper consisting of paper coated with a barium sulfate dispersion in polyvinyl alcohol and an overcoating of a photographic emulsion.

OXIDIZED CELLULOSE ESTERS. C. R. Fordyce (to Eastman Kodak Co.). U. S. 2,358,064, September 12. A partially hydrolyzed cellulose ester is oxidized with dilute aqueous permanganate in presence of sulfuric acid after which it is washed.

CELLULOSE ESTERS. C. J. Malm (to Eastman Kodak Co.). U. S. 2,358,080, September 12. Cellulose is pretreated for esterification by mixing with propionic acid and sulfuric acid in the presence of heat.

MOUNTING TISSUE. A. Abrams and G. W. Forcey (to Marathon Paper Mills Co.). U. S. 2,358,135, September 12. A mounting tissue for photographs, comprising a cellulosic sheet carrying a hot melt composition of ethyl cellulose, a plasticizer and a non-volatile solvent.

MOLDING. K. G. Siedschlag and C. F. Hilldring (to American Hard Rubber Co.). U. S 2,358,259, September 12. A method for molding thermoplastic articles composed of separate parallel sections of contrasting colors.

MELAMINE - FORMALDEHYDE RESINS. T. S. Hodgins, P. S. Hewett and A. G. Hovey (to Reichhold Chemicals, Inc.) U. S. 2,358,276, September 12. Clear stable waterwhite melamine-formaldehyde resinous compositions are prepared by heating melamine and formaldehyde with ammonia as a catalyst and heating the reaction product with a glycol.

POLYVINYL BUTYRAL. G. S. Stamatoff (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,358,355, Sept. 19. Polyvinyl butyral resins are treated by suspending an acetone-soluble polyvinyl butyral resin with polyvinyl alcohol and a polyvinyl ester in an aqueous solution in the presence of catalytic amounts of an acid substance.

CELLULOSE DERIVATIVES. H. Dreyfus, R. W. Moncrieff and H. Bates (to Celanese Corp. of America). U. S. 2,358,387, Sept. 19. Organic cellulose derivatives containing free hydroxyl groups are heated at 100 to 180° C. in a liquid acidylation medium containing the mixed anhydride of an organic polycarboxylic acid and a lower aliphatic monocarboxylic acid, thus forming the acidyl derivative of the cellulose.

COPOLYMERS. D. D. Coffman and C. E. Denoon, Jr. (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,358,444, Sept. 19. The copolymer of an ester of an alpha methylene monocarboxylic acid with a 2-vinylethinyl carbinol.

MOLD. A. A. Burry. U. S. 2,358,624, Sept. 19. Molding device for thermoplastic material.

ADHESIVES. L. Bradshaw and C. F. MacLagan (to Borden Co.). U. S. 2,358,683, Sept. 19. Dry powdery adhesive resinous materials are treated with a fluid oily liquid, thus reducing the tendency to form dust.

MOLDING. L. J. Caron (to Leominster Tool Co., Inc.). U. S. 2,358,686, Sept. 19. A device for injection molding of thermoplastic materials.

POLYVINYL ACETAL. D. R. Swan (to Eastman Kodak Co.). U. S. 2,358,836, Sept. 26. A water-soluble polyvinyl acetal in which at least a part of the acetal groups are 4-formylphenyltrimethylammonium salt acetal groups.

MOLDING. B. D. Ashbaugh (to Hydraulic Development Corp.). U. S. 2,358,956, Sept. 26. A feeding unit for an injection molding machine for use with plastic materials.

THERMOPLASTIC. D. N. Davies (to Cellomold, Ltd.). U. S. 2,358,963, Sept. 26. Cellulose acetate particles having a lubricant in powder form dispersed throughout the mass as a mechanical mixture.

MOLDING. W. R. Tucker (to Hydraulic Development Corp., Inc.). U. S. 2,359,013, Sept. 26. Process for injection molding of thermoplastic material.

POLYMERS. H. Hopf and W. Rapp (to General Aniline and Film Corp.). U. S. 2,359,038, Sept. 26. Interpolymerization products of vinyl chloride and a tetrahydrophthalic acid ester.

ETCH COATING. F. W. Adams (to Pittsburgh Plate Glass Co.). U. S. 2,359,071, Sept. 26. A matté finish is provided for a glass surface by coating with a suspension of fine solid organic plastic particles, evaporating the vehicle and exposing to hydrogen fluoride.

ETCH COATING. F. W. Adams (to Pittsburgh Plate Glass Co.). U. S. 2,359,072, Sept. 26. Glass is etched by coating with a solution of an organic plastic containing pigment insoluble in the solvent, evaporating the solvent, dissolving out the pigment and exposing to hydrogen fluoride.

MOLDED ARTICLE. H. M. Elsey (to Westinghouse Electric and Mfg. Co.). U. S. 2,359,097, Sept. 26. A molded article comprising laminated sheets of fibrous materials impregnated with phenolic resin and a surface sheet impregnated with melamine-aldehyde resin, the entire assembly being consolidated by curing under pressure with the application of heat.

PLASTICIZER. H. L. Gerhart and G. E. Eilerman (to Pittsburgh Plate Glass Co.). U. S. 2,359,103, Sept. 26. A plasticized resin is formed by copolymerizing styrene and maleic anhydride in solution in a compound such as a nitroalkane or the hydroxy derivative thereof.

GLAZING UNIT. J. H. Sherts (to Pittsburgh Plate Glass Co.). U. S. 2,359,163, Sept. 26. A glazing unit comprising an interlayer of organic plastic, glass sheets bonded to opposite sides of the interlayer and an opening through the laminate which is filled with plastic material integral with the interlayer.

PLASTIC. L. Smidth. U. S. 2,359,166, Sept. 26. An incompletely reacted urea-formaldehyde reaction product combined with a salt of chloroacetic acid as a latent catalyst.

VINYL RESIN. E. C. Britton and W. J. Le Fevre (to Dow Chemical Co.). U. S. 2,359,196, Sept. 26. A vinyl aromatic compound is emulsified in an acidic aqueous solution of a water-soluble peroxide and polymerized with heat.

ADHESIVE SHEET. E. F. Klein and C. Yates (to Beutex Corp.). U. S. 2,359,314, Oct. 3. A cellulosic sheet carrying a normally adhesive pressure-sealing sulfonamide resin, polyvinyl acetate, and a phthalic acid ester plasticizer.

LIGHT POLARIZER. E. H. Land (to Polaroid Corp.) U. S. 2,359,428, Oct. 3. A light polarizing body is prepared by heating a transparent plastic material containing birefringent crystals, applying an orienting force and cooling, thereby holding the crystals in parallel alignment.

POLYMER. H. A. Bruson (to Resinous Products and Chemical Co.). U. S. 2,359,708, Oct. 3. An aliphatic polyether polyamide.

SHUTTLECOCK. P. C. P. Booty (to Charles G. Jansky). U. S. 2,359,726, Oct. 3. A shuttlecock comprising a plastic weighted cup in which a quantity of feathers are embedded.

DYEING. R. H. Kienle and F. E. Petke (to American Cyanamid Co.). U. S. 2,359,735, Oct. 10. Polyvinyl halide-acetate is dyed by subjecting it at temperatures below 70° C. to a bath containing a dispersed oil-soluble color and at least one ester which is a non-solvent for the resin.

POLYMER. B. F. Faris (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,359,833, Oct. 10. A fiber-forming polymer is prepared by interpolymerizing hexamethylenediamine and adipic acid polymer with a polyamide comprising a bifunctional amide-forming reactant such as monoaminomonocarboxylic acids and mixtures of diamine and dibasic carboxylic acids in equal proportions.

MOLDING. G. A. Goessling (to Pro-Phy-Lac-Tic Brush Co.). U. S. 2,359,839–40, Oct. 10. Devices for injection molding of plastic materials.

POLYMER. E. L. Martin (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,359,867, Oct. 10. The reaction product of a mixture of hexamethylenediamine, adipic acid, and a polyamide-forming reactant such as a diamine and a dibasic carboxylic acid in equal proportions or a monoaminocarboxylic acid.

LACQUER. A. L. Rummelsburg (to Hercules Powder Co.). U. S. 2,359,874, Oct. 10. A lacquer comprising a cellulose derivative, a polymerized rosin ester and an organic solvent.

POLYMERS. O. E. Schupp, Jr. (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,359,877–8, Oct. 10. Solutions are formed by mixing synthetic linear polycarbonamides with alcoholic solutions of an inorganic salt such as the halide, nitrate or thiocyanate of a group I or II metal.

RECORD. J. M. DeBell (to Hercules Powder Co.). U. S. 2,359,972, Oct. 10. A phonograph record comprising shellac, a mineral filler, pine wood resin, ethyl cellulose and a plasticizer.

MOLD. C. L. Popp (to Standard Products Co.). U. S. 2,360,011, Oct. 10. A mold for plastic materials.

CELLULOSE DERIVATIVES. W. O. Kenyon and D. D. Reynolds (to Eastman Kodak Co.). U. S. 2,360,238, Oct. 10. Ethanolamino-cellulose is prepared by completely aminating and deacetylating cellulose acetate-*p*-toluene sulfonate by treating with an ethanol amine until a water soluble product is obtained.

CELLULOSE ESTERS. G. A. Kirton and J. B. Kemp (to Eastman Kodak Co.). U. S. 2,360,239, Oct. 10. Cellulose acetate butyrate is stabilized by treating with a solution of the alkali metal salt of a weak volatile acid, removing the liquid, heating, cooling and finally condensing steam on the product.

POLYVINYL ACETAL. H. K. Nason (to Monsanto Chemical Co.). U. S. 2,360,306, Oct. 10. A composition comprising a mixture of a polyvinyl acetal resin, an alkylated diphenyl and an additional plasticizer.

BOOKS AND BOOKLETS

Write directly to the publishers for these booklets. Unless otherwise specified, they will be mailed without charge to executives who request them on business stationery. Other books will be sent post-paid at the publishers' advertised prices.

Organic Chemistry

by Louis F. Fieser and Mary Fieser

Published by D. C. Heath and Co., Boston, 1944

Price $8.00 **1091 pages**

This review of the chemistry of carbon compounds contains many chapters dealing with modern applications of organic materials in industry and in the biological and medical sciences. These topics include petroleum, rubber, microbiological processes, dyes, synthetic plastics and resins. It is highly recommended as a source of interesting reading and reliable reference for information on organic compounds. G.M.K.

Entirely Business

by Herbert S. Spencer

Niagara Frontier Publishing Co., Inc., Buffalo, N. Y.

Price $1.00 **99 pages**

This informative book has been written for all people engaged in selling. Taken from original articles appearing in the Durez Molder, chapters cover all phases of salesmanship including a special section by Raymond Loewy on Designing to Sell. Interesting sales experiences and practical suggestions as well as clever cartoons make this book a helpful and important guide for all salesmen.

Plastics Molds
2nd Edition

by Gordon B. Thayer, M. E.

Published by American Industrial Publishers, Fairmount Cedar Bldg., Cleveland 6, Ohio

Price $3.50 **136 pages**

Starting with the statement that molds for plastics materials have been made in some manner for centuries, the author points out that the advent of the newer plastic materials has completely changed the accuracy and requirements needed for forming tools.

In this expanded edition of the author's first book on plastics molds, the fundamentals of plastics mold design are discussed and applied for representative-type molds. Compression mold types are classified for study as are transfer, jet and injection molds. All types are presented as units and are also broken down into their elements of design and construction. The usual product design considerations as well as a summary of practical points of mold construction are covered. F.S.

★ AMERICAN SOCIETY FOR Testing Materials, 260 South Broad St., Philadelphia 2, Pa., has published a "Symposium on the Applications of Synthetic Rubber," to fill the need for authentic technical information on the uses of various synthetic rubbers. Outstanding authorities in this field have contributed material of unusual value to the pamphlet. Copies may be obtained at $1.75 (cloth binding) or $1.50 (paper binding).

★ A TECHNICAL BULLETIN ON Geon latex has been issued by the Chemical Div., B. F. Goodrich Co., Cleveland, Ohio. General properties and compounding information on the latex — a colloidal dispersion of vinyl chloride types of polymers in water — are given. The nature of the material, its stability, physical properties, compounding, including the admixture of water soluble liquids of water soluble or dispersible solids with the latex, and suggested formulations, are explained.

★ FORMS, PROPERTIES, FABRIcation procedures and uses of polyethylene resins is the subject of a 12-page illustrated booklet issued by Carbide and Carbon Chemicals Corp., New York, N. Y. These semirigid, translucent plastics possess many unusual properties. The art of compounding and using these resins has not as yet been developed fully, but it is expected that the properties will be even further improved in the future and that even more exact processing information will be obtained.

★ AN 8-PAGE LEAFLET DESCRIBing Marblette cast phenolic resins and liquid phenolic resins has been received from Marblette Corp., Long Island City.

★ A COLORFULLY ILLUSTRATED folder describing the general properties of the Celanese plastics family has been published by Celanese Celluloid Corp., Div. of Celanese Corp. of America, New York, N. Y. Lumarith, aero-quality Lumarith, Lumarith X and E.C., Celluloid and Vimlite are reviewed in terms of the work they have been doing during the war. Postwar applications are suggested.

★ BULLETIN NO. 135, RELEASED by Lyon-Raymond Corp., Greene, N. Y., entitled "Die Handling Made Easy," discribes equipment manufactured by the company for the lifting and moving of heavy dies. The trucks which can be supplied in capacities up to 30,000 lb., can be powered by 1) hydraulic foot-operated pump, either single- or 2-speed, 2) hydraulic hand-operated 2-speed pump, 3) electric motor-driven hydraulic pump or 4) gasoline engine-driven hydraulic pump.

★ AMERICAN INDUSTRIAL PUBlishers, Cleveland, Ohio, have released Volume 1 of their know-how library — "A Brief Survey of Plastics." Intended to deglamourize the exaggerated statements which have been made about what plastics are going to be in the future, this over-all review of plastics, written by an experienced plastics engineer, contains a clearly written account of the advantages and disadvantages of plastics, the types of materials and the classes into which they fall. The volume also includes a detailed explanation of molding and fabricating methods. Timely illustrations clarify the text.

★ WABASH APPLIANCE CORP., Brooklyn, N. Y., manufacturers of Birdseye infrared radiant heat lamps, have issued an illustrated booklet on the uses and the various limitations of the near infrared process.

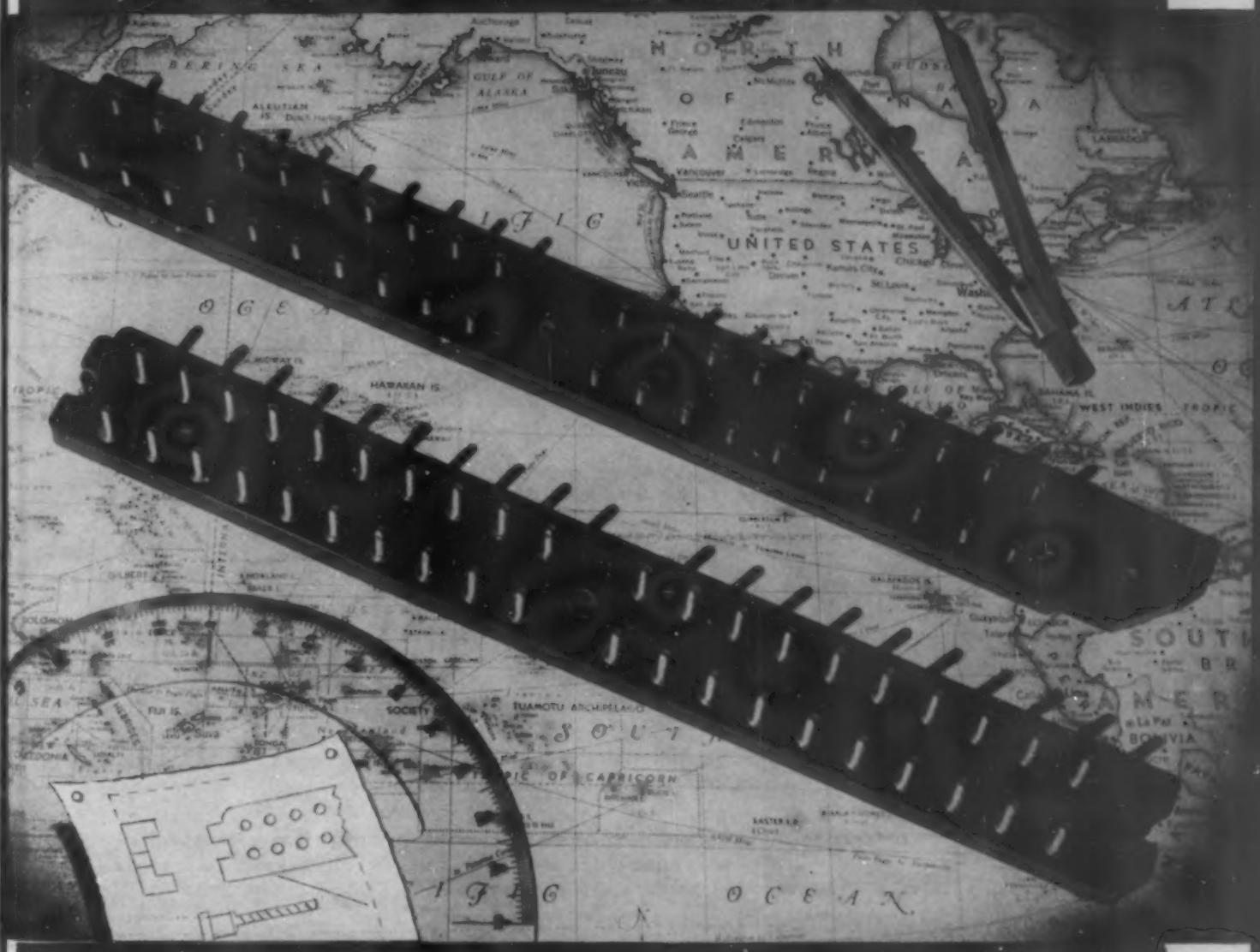
★ SILCOCKS-MILLER CO., SOUTH Orange, N. J., has put out an attractively illustrated booklet presenting the story behind the many and varied products which the plant produces.

★ "DURAMOLD—MOLDED STRUCtures of Precision" is the title of a booklet, published by Duramold Div., Fairchild Engine and Airplane Corp., New York, N. Y., which discusses the present achievements and future possibilities of this material.

Duramold is said to meet the requirements of moldability to complex curvatures, elimination of rivets and bolts, smooth surface in terms of aerodynamic drag, strength, stiffness, durability, thin section (ideal for monocoque construction), light-weight, resistance to climatic conditions, resistance to fungus and bacteriological deterioration. It is understood that this material requires a minimum of maintenance.

A U. S. Navy IDEA... *Molded in* PLASTICS

Back of the batteries of modern molding presses and precision production facilities at Tech-Art is one asset that stands pre-eminent. It is that intangible knowledge of product engineering and skill in the field of plastic production that is contained in the minds and hands of Tech-Art's engineers and craftsmen. Add to this precision mold building by Tech-Art's own master mold builders and Tech-Art's wide experience in the selection of the right plastic material for each particular product and you have the reasons for so many Tech-Art Plastic Success Stories. It is, indeed, the combination of all these factors which so often creates the hair-line difference between an outstanding or mediocre success in plastic productions.



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Quad Erat Demonstrandum

TECHNICAL NOTES: ***This molded piece is 14 inches in length with forty metallic terminal inserts molded in each unit. It is made from a non-conducting, high impact plastic material.***

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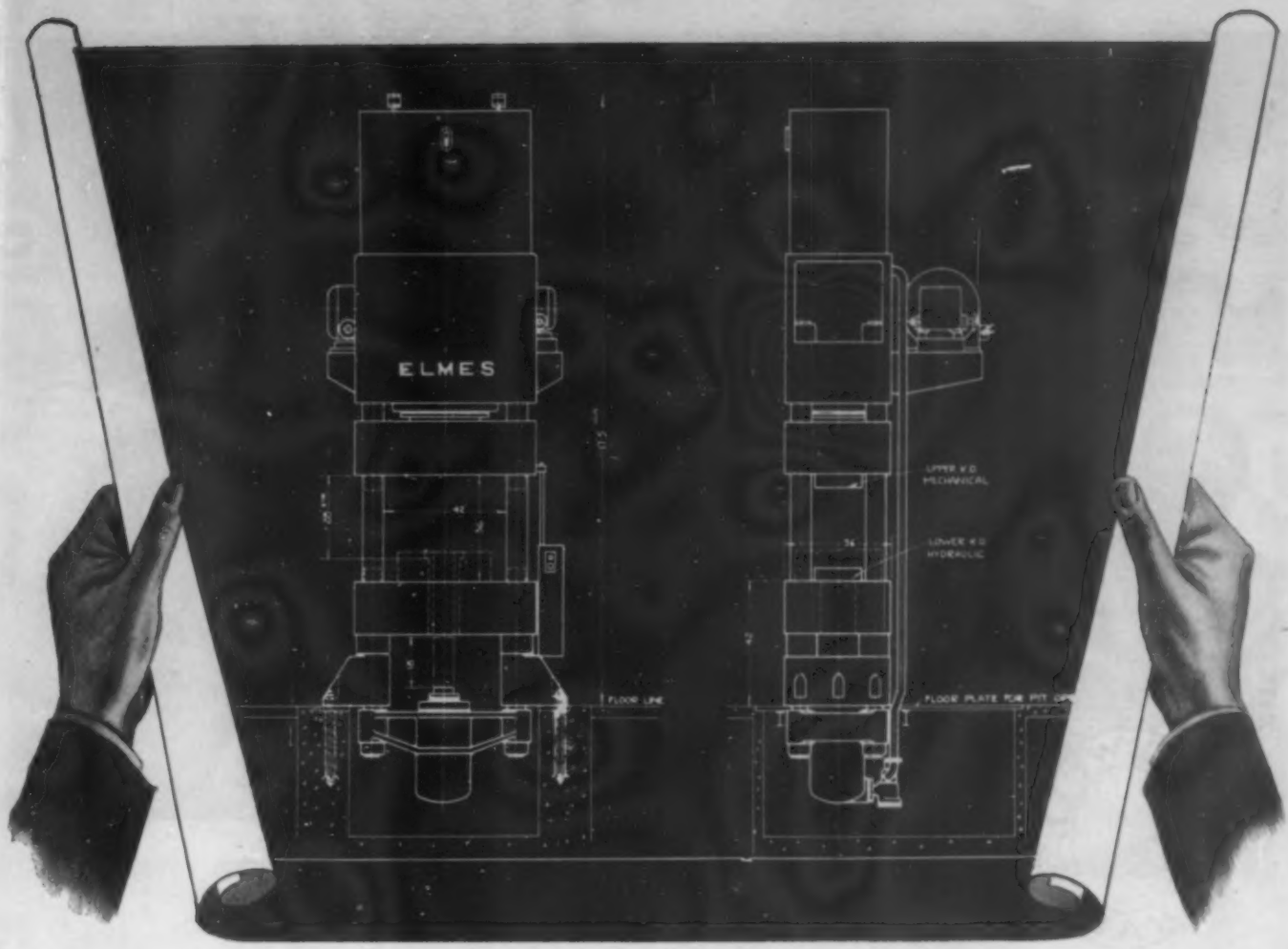

Tomorrow Is in Your Hands

Elmes engineers don't believe in the theory that "tomorrow never comes." Looking ahead has been their business for nearly a century, and each "tomorrow" has proved the wisdom of their viewpoint.

Tomorrow you will want even greater molding speeds; more versatile equipment; exact accuracy and—above all—simplicity of operation. These things you can have in Elmes presses, and you won't have to wait too long. Already, new designs are in the shops for the building of pilot models.

One of these new developments is the combination compression and transfer molding press shown above. The loading cylinder is at the bottom in full view of the operator. Pump, motor, and control valve are mounted aloft to save floor space. The press has both top and bottom knockouts, the latter hydraulic, and exceptionally high speed for quick closing of molds and injection of materials.

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Combining the desirable *new* with the dependable *tried-and-proved* is progress at its best. Reconversion, in itself, cannot possibly obsolete everything that has gone before, nor can either your prewar product or ours—regardless of how good—necessarily be good enough in the days that lie ahead.

For Elmes equipment we pledge a continuation of the progressive thinking and painstaking craftsmanship that contributed in no small way to the expansion of the plastics industry. And we invite you again to "Put Your Pressing Problems Up to Elmes" in preparing for tomorrow.

Elmes Engineering Works of American Steel Foundries, 225 N. Morgan St., Chicago 7. Also manufactured in Canada.

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Plastics Research Division

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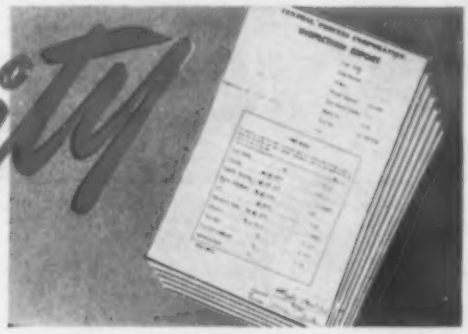
SPECIFICITY is the quality of being precisely adjusted to a specific application. *For example, the C.P.C. Resin developed for Owens-Corning Fiberglas.* To make Fiberglas wool into sawable boards, curved pipe coverings, etc., Owens-Corning originated a process that required a synthetic resin binder—to make possible *precision control* of the final resilience or rigidity of each Fiberglas product. C.P.C. developed the resin that met, and continues to meet, all the exacting requirements of that specific process.

RESIN FACT #2

IT TAKES *Uniformity* to KEEP ON doing a job right!



C.P.C. PRODUCTION STABILIZED Specification Resins are held within such extremely close range of chemical variation that *no perceptible variation of performance* in practical use occurs. Thus the performance of *every* shipment of C.P.C. Resin delivered is identical with the first. Large industrial users attest this fact—and *with each shipment*, a C.P.C. Laboratory Inspection Report describes the complete chemical characteristics of the resin delivered.

C.P.C. RESINS are developed only for specific applications—job-tested—and production stabilized—thus assuring *exact* and *uniform* performance.

That is why progressive industrial firms come to C.P.C. for practical solutions to difficult resin problems—for resins *precisely adjusted* to specific applications and which *never* appreciably vary in performance.

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IF YOU HAVE A RESIN PROBLEM **draw freely upon the wide experience of C.P.C. We will gladly work with you on any resin problems or discuss with you the possible advantage of using resins in any operation or process. Write Central Process Corporation, 1401 Circle Ave., Forest Park, Illinois.**

... for Specificity and Uniformity in Resin

The sixteenth in Aico's plastics applications series.

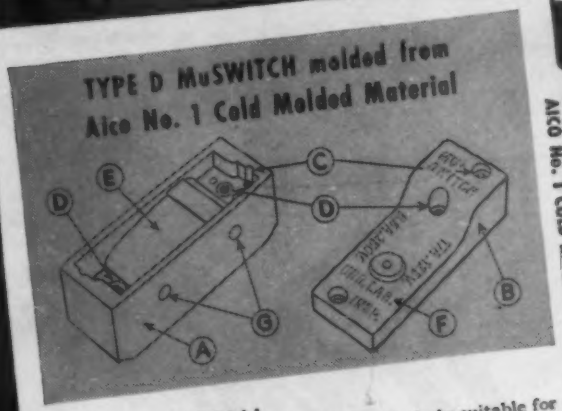
COLD MOLDED PLASTICS have a PART... IN BOMBING THE ENEMY!

AICO'S fast cold molding process helps to do some of the "stepping up" in America's new stepped up multi-bomber program.

The case for this Type D MuSwitch, used in the Army's giant B-29 bomber, is molded rapidly and economically at Aico. Bases and covers are produced at a rate of several thousand per week.

Aico cold molded plastics have excellent properties for electrical parts applications. Aico's 29 years of experience is a guarantee of expert plastics engineering.

TYPE D MuSWITCH molded from Aico No. 1 Cold Molded Material



TYPE D MuSWITCH
AICO No. 1 COLD MOLDED MATERIAL

MOLDING MATERIAL

Aico No. 1 cold molded material is particularly suitable for use in electrical parts. It has high heat resistance (will withstand temperatures up to 600° F.), low heat conductivity, and assures freedom from arcing. Plastic materials offer the additional advantage of light weight—important in aircraft parts.

MOLD DESIGN

A single cavity mold was designed for each of the two parts of this switch case—base (A) and cover (B). Design for the base includes holes (C) for assembly. Threaded metal inserts (D) are molded in, demanding extreme accuracy in the mold design. Corresponding design features are provided in cover (B) as indicated at points C and D. Note indentions and planes (E) of interior surface designed to hold interior mechanism firmly in place. Embossed lettering (F) is confined to flat surfaces.

MOLDING METHOD

The cold molding method permits high production at a low mold investment, producing durable and accurately molded parts speedily and economically.

FINISHING

Finishing operations on the Type D MuSwitch consist of drilling mounting holes (G) in base, brushing and tapping inserts, and grinding joining surfaces of base cover.

Write on your business letterhead for additional copies of Aico file cards Nos. 1 to 15.

AICO

Aico PRECISION MOLDING
29th Year

AMERICAN INSULATOR CORPORATION, New Freedom, Pa.

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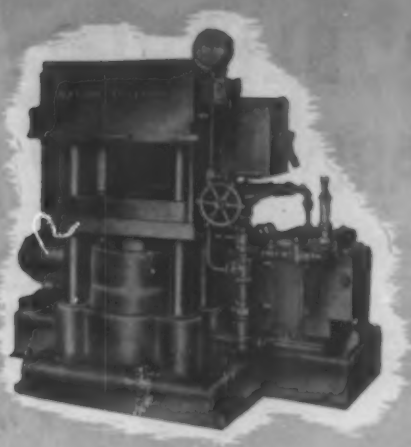
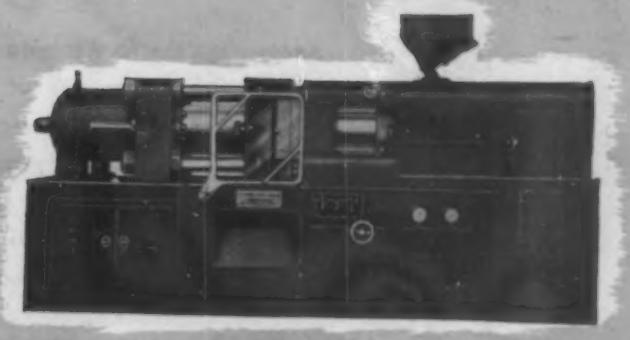
Aico
PRECISION MOLDED FOR ACCURACY

From making molds



To molding plastics....



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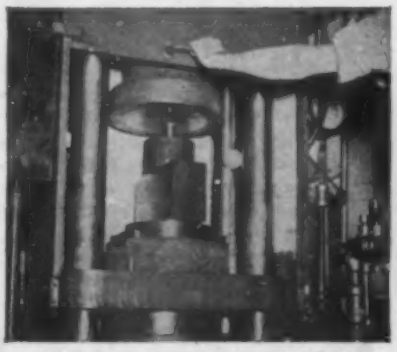

Hobbing cavity in a plastic mold on a Watson-Stillman Hobbing Press at The Parker Stamp Works, Inc., Hartford, Conn.

ALL W-S equipment embodies operating and production features consistent with latest trends in plastic materials and molding techniques. Each type of machine is thoroughly tested and proved at the factory under conditions duplicating actual operating requirements.

Facilities of the W-S laboratory are always available to molders for testing and molding plastics with various types of equipment and dies. Why not select your molding machines and operating equipment from this complete Watson-Stillman line? When you bring your problems to us you deal with an organization which has been actively and intimately associated with the Plastics Industry from its beginning. Write or call The Watson-Stillman Co., Roselle, New Jersey.

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SEBACIC ACID

Specific gravity	1.085 25/15°C
Melting point	128°C
Neutralization equivalent	102
Free fatty acid	98.5%
Moisture	0.15%
Mol. weight	202.14

BUTYL ROLEATE

Free fatty acid	2%
Butanol	0.2%
Moisture	0.2%
Color	Red

DIBUTYL SEBACATE

Purity	98.5% Minimum
Specific gravity	0.935 20/20°C
Acidity as Sebacic	0.3% Maximum
Color	15Y, 3.5R
Butanol	0.1% Maximum
Flash point	380°F
Boiling point	344°C. @ 760 mm. 177–180°C @ 3 mm.
Water solubility	Less than 1% @ 25°C
Freezing point	11°F
Weight per gallon	7.8 lbs.
Index of refraction	1.4391 @ 25°C
Dielectric constant	3.6
Power factor—60 cycles	6

CAPRYL ALCOHOL

Specific gravity	0.815/20°C
Mol. weight	130.23
Flash point	172°F
Distillation range	176.8/179.9°C
Refractive index	1.4266 @ 20°C
Lbs. per U.S. gallon	6.81
Boiling point	178/179°C
Moisture	0.25%

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New method of molding by extrusion

by A. D. FERGUSON*

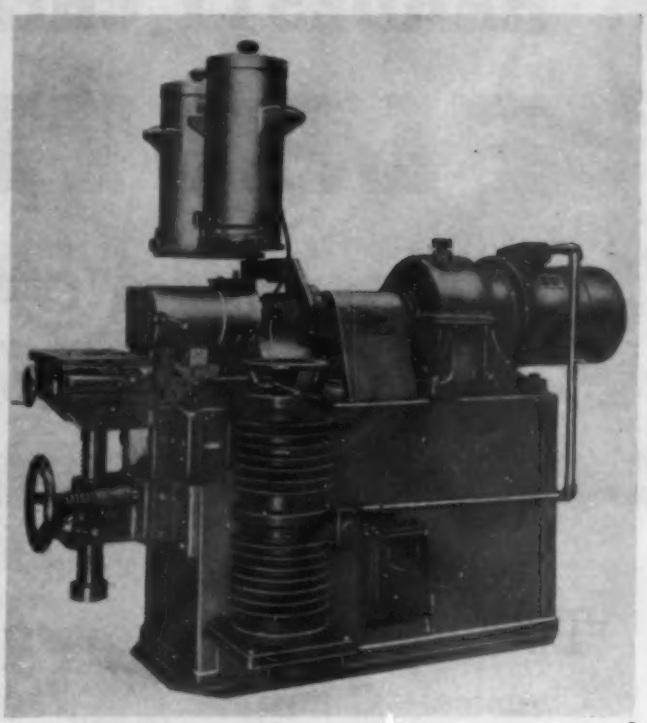
A NEW method of molding certain thermoplastics, developed by Metropolitan-Vickers Electrical Co., Ltd., has found important applications in war production. Up to the present time, the new method has been confined to the manufacture of polyethylene moldings, but there are strong possibilities of utilizing the new method for some other thermoplastic materials.

The new method of molding is by extrusion wherein the material is forced by means of a screw extruder into a closed mold. A suitable nozzle is formed on the end of the extruder barrel to which the mold is clamped.

The essential difference between this process and present compression, transfer and injection methods lies in the fact that the molding is done at a low pressure—between 200 and 400 p.s.i.—which can easily be regulated to suit a great variety of articles. Since the screw will deliver plastic continuously so long as it is fed with molten material, there are very wide limits to the size of articles that can be made from this method.

Figure 1 illustrates in diagrammatic form the principle of the new method. *A* is the forcing screw and *B* its associated barrel, which is heated by coil *C*. *D* is the hopper that contains the material to be molded and is refilled from container *E*. *F* is the mold and *M* a typical molding. As can be seen, the mold is provided with a filling hole which engages with the nozzle on the end of the barrel against which the mold is pressed by a screw. The driving motor *G* is capable of speed regulations.

When the mold is full, it is important that the pressure inside the mold be maintained during the cooling period to make up for the contraction of the material on cooling. This is especially true if the molding is large and bulky. A small clearance is provided between the screw and the barrel for mechanical reasons and to allow for the necessary slip of the material when the mold has been filled. Otherwise, the pressures in the barrel and mold would become excessive.



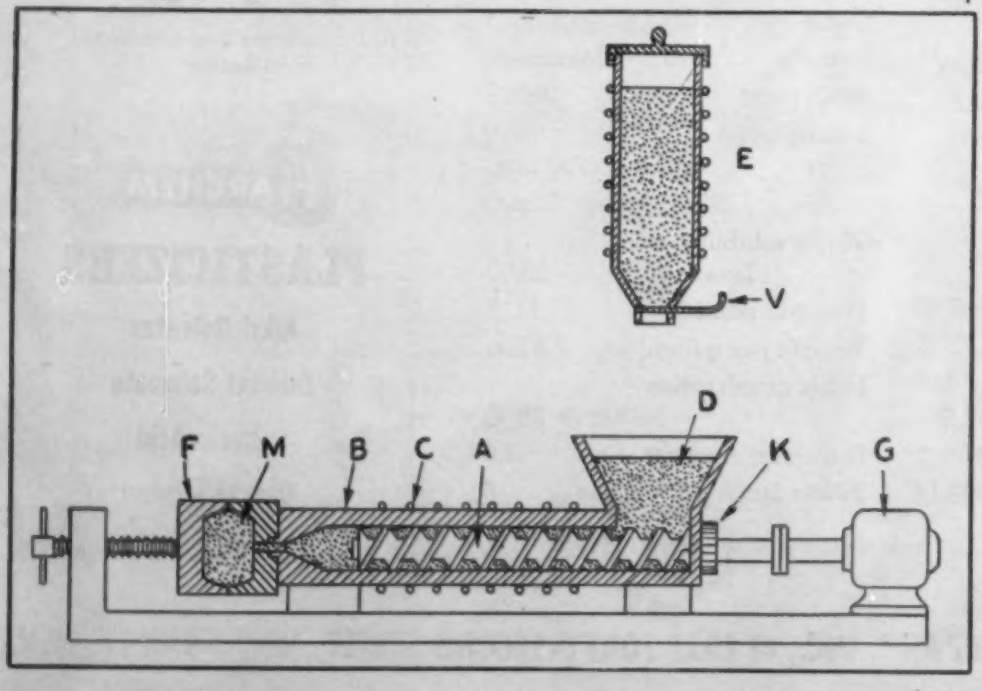
2

To assist the material to enter the screw, it is desirable to provide a roller feed (Fig. 3). *A* in this drawing is the roller feed which is driven by screw *B* by means of spur gearing. A gear wheel is shown mounted on the screw shaft at *K* in Fig. 1.

Usual practice is to heat the material in the container until it is plastic and then to fill the hopper *D* by opening the valve *V* (Fig. 1). In certain cases, (*Please turn to page 206*)

* M.I.E.E., Metropolitan-Vickers Electrical Co., Ltd.

1



1—The principle underlying a new method of extrusion molding of thermoplastics is here shown in diagrammatic form. Explanatory data for the legend is given in the accompanying text. 2—A typical machine employed in screw extrusion molding which is driven by a variable-speed motor through a double reduction-gear box

Versatility

If you combine metal with plastics, remember that The Chicago Screw Company is the foremost producer of quality Brass and Steel Screw Machine Products for more than 72 years.

Our engineering ability and modern production facilities are versatile enough to handle any of your screw machine problems, including all secondary operations, regardless of size, shape or form, and in unlimited quantities.

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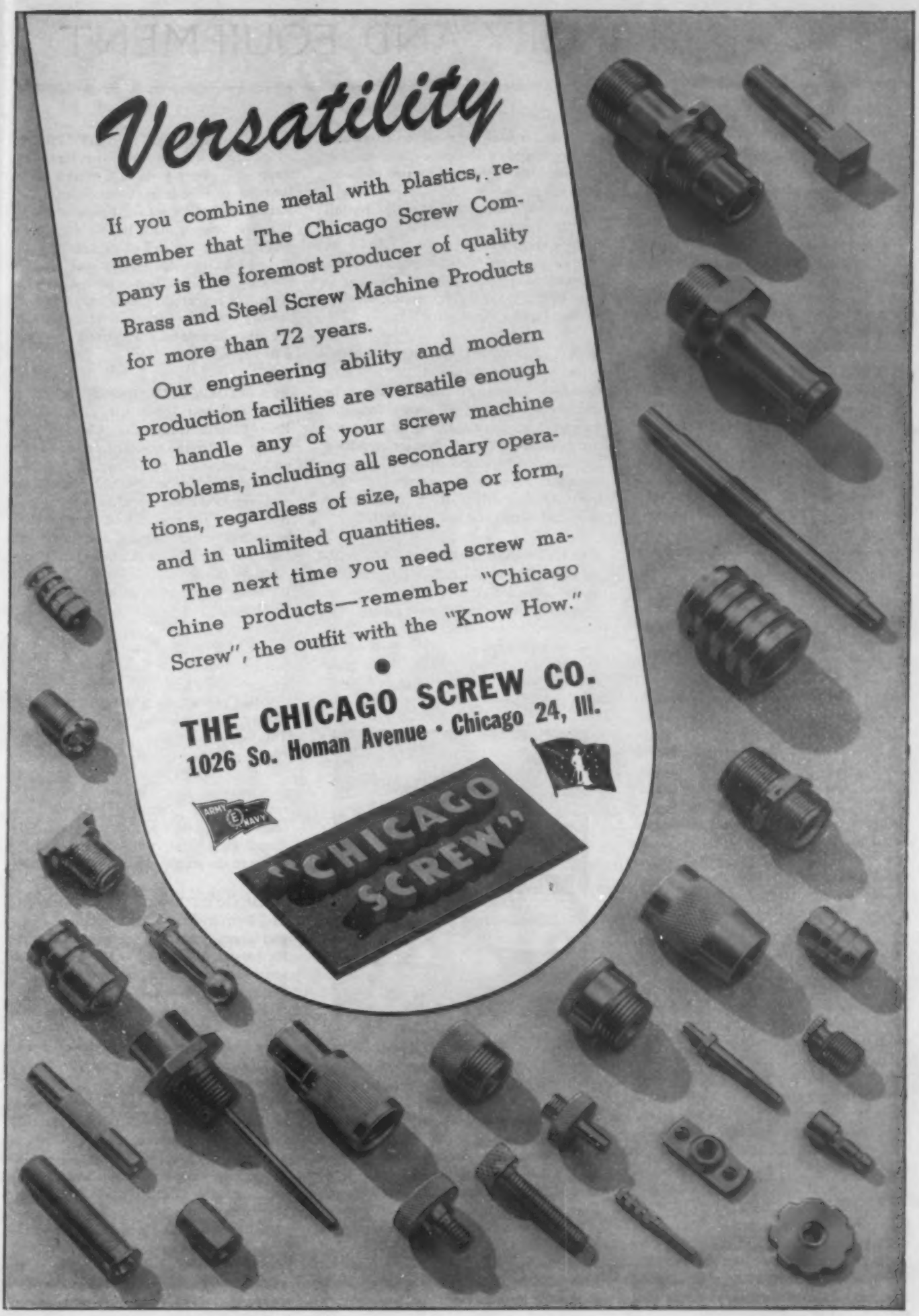


NEW MACHINERY AND EQUIPMENT

★ A REMOVABLE AND REVERsible roller top for hydraulic elevating tables is a new optional feature developed by Lyon-Raymond Corp., Greene, N. Y. The unit, which can be placed to convey from front to back or from side to side, fits over the permanent table top, eliminating the necessity for bolts or other fastenings and making possible instant installation or removal. It consists of a rigid, welded framework and supporting ball bearing conveyor rolls.

★ DESIGNED TO MEET THE NEED for a laboratory-type device that provides for efficient, economical extrusion of all types of plastics materials, the Pelco extruding machine, manufactured by Midwest Production Machine Co., Columbus, Ohio, is claimed to be applicable to all laboratory work involving the development, design, testing, application or production of extruded plastics as well as the job-lot production of extruded shapes in limited sizes. The unit, which weighs 100 to 165 lb.—depending on the type of heating element used—is available in three models: B-100, circulated oil heating; B-101, electrical resistance heating; and B-102, steam heating.

★ AMONG THE MANY APPLICAtions of the preset interval timer manufactured by Paragon Electric Co., Chicago, Ill., are heat treating, batch mixing, rubber curing, pump operation, power disconnecting, machinery operation and plastic molding. The unit can be preset to allow an operation to continue for a predetermined time and to close or open a circuit at the end of that time. To set, the pointer, which operates over a clear line dial, is set to the desired time limit. When the pointer reaches zero a switch automatically stops the timer.

★ LEEDS AND NORTHRUP CO., Philadelphia, Pa., announces a micromax electric control of the duration-adjusting type, which is said to regulate electric input to hold temperature at a selected control point or program, with the dependability necessary to obtain efficient balance among product uniformity, speed of output and flexibility of operation. Input of electricity is either "full-on" or "full-off," and automatic timing controls heat regulation while current is on or off.

★ A HEAVY DUTY POLISHING lathe, which gives a faster, better and more uniform grind, is manufactured by Jones Engineering Co., Ellwood City, Pa. The machine, designed for bench or stand mounting, is a production machine unit which operates with the use of two contact rolls equipped with fast-cutting endless abrasive belts. It is built for two 14-in. diameter, 3-in. face contact rolls, has a $1^{11}/_{16}$-in. diameter shaft and is 34 in. in over-all length. Spacing between the inside faces of the wheels is 24 in., with 9 in. from the base to the center shaft. Equipped with a 3-groove V-belt motor shaft, the unit is used with a 2-, 3- or 5-hp. motor, which is mounted under the bench.

★ A COMPACT VARIABLE SPEED drive has been perfected by Lombard Governor Corp., Ashland, Mass. The unit makes individual control possible for each machine, thereby eliminating the disadvantages of a belt connection with a central power system. In addition, since the speed drive is about the size of the AC motor which drives it, a considerable saving in weight and space is effected.

★ KEYSTONE PLASTIC ENGINEERing Co., Chicago, Ill., has introduced a newly designed compression press for which it claims improved molding efficiency on the basis of results obtained from extensive research work and practical technical experience. This 200-ton press which is built to run two large molds, has two supplementary rams that do the actual opening and closing of the molds outside of the center pressure area of the unit itself. While one supplementary ram is opening one of the molds for the ejection of the part and subsequent reloading, the second mold is receiving a high-pressure cure in the press proper. Both molds are attached to guided platens that slide from side to side, and can be located speedily in either the high- or low-pressure area.

This departure in compression presses, the manufacturer claims, allows one unit to do the work of two, at much less cost than the operation of one large semiautomatic installation.

★ A PRECISION PUNCH PRESS which can be used as a pipe vise, tensile or compression testing machine or as a shear for plate or rounds has been designed by Reimuller Brothers Co., Franklin Park, Ill. The press is made in one size, has a 5 × 6 in. platen with 7 in. ram movement, and can be mounted on a portable stand for easy transportation. Hydraulic foot control is operated by two levers, one to apply pressure up to the rated tonnage and the other for release. The latter lever has a two-speed return.

★ A COMPOUND REPLACEMENT turret tool post, model CR, produced by Enco Manufacturing Co., Chicago, Ill., is said to offer the utmost in tool rigidity under high-speed production and to remove a possible source of chatter and inaccuracy in the compound. The machine is designed for engine and bench lathes with low center heights, and it clamps rigidly on the bolt circle, mounting maximum tools and tool holders. Range of the lathe swings covered extends from 9 to 36 inches.

★ DELTA MFG. CO., MILWAUKEE, Wis., is manufacturing a dust collector, designed for use with any individual machine used in grinding, polishing, buffing, sanding or any similar operation. The unit is activated by a powerful fan which sucks fine and heavy dust and small particles through an air filter. The filter is permanent and cleanable, has low air resistance and is entirely fireproof. For collecting "flour fine" dust, a specially woven glass filter, which is attached directly to the standard filter, is available.

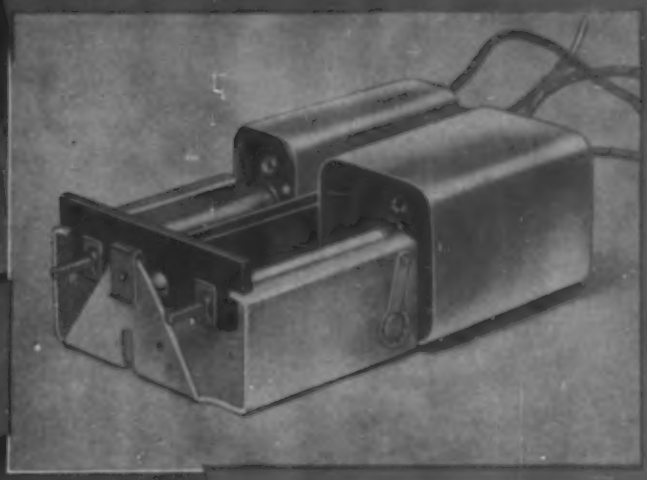
★ DETROIT MOLD ENGINEERING Co., Detroit, Mich., has announced a new and larger sized set of pre-fabricated parts for plastic mold bases. Known as 55-S series, the set is $23^1/_2$ in. long and 12 in. wide, and is designed to give the mold maker a complete set of parts to build up his own mold base. Sprue bushing, return pins, dowels and screws of proper length and size are also furnished with the set.

★ BURGESS VIBRO-TOOL, MANUfactured by Handicraft Div., Burgess Battery Co., Chicago, Ill., performs almost every type of marking, engraving, filing or chiseling. Operating on a 110-volt AC current at a rate of 120 reciprocal strokes per second, the unit is used in the same manner as a pencil, and has the ability to engrave numbers or designs on plastic, steel, glass, stone and wood or to gouge, file and cut thin woods and plastics.

THE *Self-Retaining* "U" Type SPEED NUT

SPEEDS UP AND IMPROVES ASSEMBLY OF STOVES, RADIOS AND MOTOR VEHICLES

Self-retained "U" nuts permit blind assembly of stove panels and door liners. They fasten parts securely, yet are resilient enough to prevent enamel damage.



"U" nuts fit over a fibre bracket holding automatic tuning screws. Spring prongs of Speed Nuts provide correct tension to permit adjustment of core screws.

Heavy duty "U" nuts fasten auto muffler bracket to frame. One operator makes complete attachment with power screwdriver; as "U" nuts are self-retained in position.

"U" type SPEED NUTS are easily and quickly applied — just snapped by hand into screw-receiving position — no welding, riveting or clinching necessary. No wonder "U" nuts SPEED UP product assembly!

"U" type SPEED NUTS hold tight — their arched prongs absorbing vibration to prevent loosening. Yet, their resiliency prevents damage to the parts they hold. No wonder "U" nuts IMPROVE the finished product! Available in many shapes and sizes, "U" type SPEED NUTS fit a wide range of thicknesses—metal plastic or glass.

Send us your design details and we'll show you how SPEED NUTS can cut assembly time and cost and improve the quality of your product too. Write today!

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In Canada: **Wallace Barnes Co., Hamilton, Ontario.** ***In England:*** **Simmonds Aerocessories Ltd., London.**

Speed Nuts* PATENTED

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FASTEST THING IN FASTENINGS

WASHINGTON ROUND-UP

R. L. VAN BOSKIRK, Washington Editor

Formaldehyde

As we go to press, there is only faint hope that there will be enough formaldehyde to meet all plastics demands in the period before the war with Germany is ended. The shortage of formaldehyde used in the manufacture of phenolic and urea formulations reached such proportions that, in November, even allocations for military use were curtailed to some degree. The basic shortage is in methanol, from which formaldehyde is produced. The methanol shortage is the result of the recent conversion of facilities producing methanol to ammonia. There may be a partial reconversion to methanol, but there still will not be enough to meet all plastics demands. Furthermore, there was a sudden increase of methanol shipments for Lend-Lease.

The shortage in ammonia was unexpected, for some plants had been closed down early in the year. However, recent military campaigns showed a need for more ammunition of which ammonia is a necessary component. Furthermore, great quantities of ammonia are going into a larger fertilizer program than was ever dreamed of in the past. Plastics operators have no intention of complaining about use of methanol for war supplies by our allies or for the fertilizer program, but they are certainly entitled to ask for evidence to prove that methanol used in foreign shipments and in fertilizer is producing more toward winning the war than if it were to go into plastics.

When queried on the subject of methanol being used as a substitute for ethyl alcohol in industrial uses, WPB officials vigorously denied any such diversion and claimed that on the contrary ethyl alcohol was being used as a substitute for methanol.

Will plastics orders be revoked on V-E Day?

There is considerable guessing as to what will happen to the various plastics raw materials orders immediately after the defeat of Germany. In order to keep company with the other guessers, here is the MODERN PLASTICS forecast based on how conditions look at this moment. If German defense continues as at present, it may be some time before this eventful day occurs and consequently many changes may take place in the raw materials situation, but if Hitler throws up the sponge before January 1, our information leads us to the following conclusions:

Acetate and butyrate—Adoption of paragraph (*f*) of Order M300 has, of course, freed all molding powder for civilian uses. But there is still not enough to meet the demand for civilian items and it is understood that military requests for November are showing a continued increase as they have during the last 3 or 4 months. Despite the large percentage of acetate and butyrate used for civilian goods, it is doubtful that the allocation order will be revoked since a certain amount of these plastics will be needed for military uses as long as the war with Japan lasts, and paragraph (*f*) takes care of redistribution insofar as civilian uses are concerned.

However, it is quite certain that much larger quantities will be available for civilian uses after "V-E" Day. Some persons think the supply will continue on a limited basis because of shortages in acetate flake and phthalate plasticizers. But the flake shortage, which has been caused largely by increased demands for sheeting, should be greatly curtailed after the European war is over. The phthalate situation is a little more complex because phthalic anhydride, from which plasticizers are made, is also used for insect repellent and ammunition. Although the demand for insect repellent will be increased as the operations in the Pacific become larger, it is not believed that this demand will come anywhere near taking up the slack which will result from a curtailment of the ammunition program after Germany is licked.

Phenolics—The phenolic situation is tied up at present by the formaldehyde shortage. However, it is presumed that after the fall of Germany the supply of formaldehyde will be sufficient to make all the phenolic resins that are needed. At this writing we can see no possibility for total revocation of the order—too much phenolic goes into the war program and large quantities will still be needed for the war with Japan. Furthermore, there will always be a threatened tightness in phenolics as long as benzol continues to be used in such large quantities for high octane gasoline and synthetic rubber. It is very possible that the phenolic order will be amended so that paragraph (*f*) can be adopted and all civilian uses put on the same basis as acetate.

Urea and melamine—At present, the formaldehyde situation makes the urea resin supply problem difficult, but it is presumed that formaldehyde will come into full production within a month or so after "V-E" Day. When that time comes it seems likely that the urea order may be revoked. Perhaps it will be necessary to retain control over melamine because practically all of this plastic is going into the war program.

Polystyrene—This is a difficult situation to forecast. Much depends on whether or not the Government calls upon private industry to deliver part of its production of styrene monomer for synthetic rubber. At present, privately produced styrene is going entirely into the plastics program, practically every pound being turned into military or highly essential civilian uses. The capacity available for making polystyrene is capable of producing much more of the material than is being used at this time, but there is not enough styrene monomer to meet the demand. The basic shortage is in benzol, which is used for aviation gasoline, rubber and phenol, and until that shortage is remedied our guess is that polystyrene will remain under control. However, it is probable that arrangements will be made soon whereby after "V-E" Day fair quantities of polystyrene may become available for civilian use under paragraph (*f*) of M-300.

Ethyl cellulose—This will probably remain under control. Like polystyrene, it is being used primarily for military purposes. Some quantity was recently released to civilian uses in order to maintain plant operations in anticipation of large military requirements.

Acrylics—No doubt there will be a tremendous cutback in the amount of acrylic sheeting used in the aviation program, but this will not mean that acrylics of all sorts will be available for civilian use in large quantities. It is doubtful that the controlling order will be revoked until the Japanese war is well along due to a shortage of metallic sodium which will necessitate restricted production of acrylics on a high essential level indefinitely.

Vinyls—It is inconceivable that the vinyl order will be revoked, but it is certainly possible that several of the vinyls will adopt paragraph (*f*). For example, polyvinyl chloride, with a less than 92 percent content, will no doubt be freer and large quantities of it should become available for civilian production. Most of the other vinyls are heavily involved in the naval program. Their production is still limited, and there seems to be no possibility that they will come into even comparatively free supply until after new facilities now building, are in production. If new production is sufficient to supply more than enough for military needs, the particular vinyls involved—vinyl chloride, vinylidene chloride, etc.—will be placed under a separate schedule in Chemicals Order M-300 so that they may take advantage of paragraph (*f*).

It is interesting to note that a number of industry advisory committees have recommended that their industry control orders be kept in force after "V-E" Day.

1. The Marine Paint Industry has requested automatic preference ratings after "V-E" Day. This (*Please turn to page 202*)

Using a new *McDonnell-developed* molding technique which employs a new resin also developed by our organization, we are now able to mold plastic structures which are *almost unlimited in size.*

Possessing characteristics of great impact, flexural, compressive, and tensile strength, such plastic is relatively light in weight and can be produced in any desired color or translucency.

Typical of structures produced by this new molding method, is a *droppable fuel tank* more than *ten feet long*—molded at a pressure of only 5 p. s. i. and oven-cured at a low temperature.

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We shall welcome inquiries from interested industrial designers and manufacturers.

PLASTICS DIVISION

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NEWS OF THE INDUSTRY

★ TO COORDINATE THE TECHnical knowledge, sales engineering, research, production and distribution methods for all plastics and resinous products which they are producing, Union Carbide and Carbon Corp., New York, N. Y., has correlated the activities of their various units in a new plastics group. Bakelite Corp., New York, N. Y., a division of this company, will carry on the sales activities of the plastics group, handling Bakelite, Vinylite, Vinylseal, Halowax, Zyrox and other products of Carbide and Carbon Chemicals Corp., New York, N. Y., and Linde Air Products Co., also of New York.

★ HARRIET E. RAYMOND, ADvertising manager of Celanese Celluloid Corp., Plastics Div., Celanese Corp. of America, N. Y., has been appointed assistant advertising manager of Celanese Corp. of America, Newark, N. J.

★ CONTRARY TO A PREVIOUS statement that there is a critical fabric shortage in the laminating industry, Owens-Corning Fiberglas Corp., Toledo, Ohio, has announced that because of added equipment in their plant, glass cloth is now available without priority. The company states that this cloth may be used with resins having cure pressures up to 1200 lb. per square inch.

★ HERCULES POWDER CO., WILmington, Del., announces the appointment of Luke H. Sperry to the position of director of engineering and of Ernest S. Wilson to that of chief engineer of the company.

★ MICHIGAN MOLDED PLASTICS, Inc., Dexter, Mich., have established a new branch office for New York state at 250 Delaware Ave., Buffalo, New York, under the supervision of Charles Larkin II. The company is also represented by the following men: James T. Libbey, 6432 Cass Ave., Detroit, Mich.; L. R. Christiansen, 225 Fifth Ave. Bldg., Moline, Ill.; W. E. Campbell, Box 1041, Dayton, Ohio; and E. W. McGrade, Porter Bldg., Kansas City, Missouri.

★ A NEW COMPANY, TO BE known as Precision Plastic Products, Inc., has been formed by George T. Erckman, V. P. Cutler and M. V. Gelder at 5 North Wabash Ave., Chicago, Ill. The firm will engage in manufacturing and jobbing plastic display advertising products.

★ WORD HAS BEEN RECEIVED that Lee T. Bordner has joined Chicago Molded Products Corp., Chicago, Ill., as district sales manager.

★ INTERNATIONAL CELLUCOTton Products Co., Chicago, Ill., has named E. W. Fairweather as manager of its central sales division and placed R. J. Potter in charge of all sales training and development of the company. Both Mr. Fairweather and Mr. Potter will have offices in Chicago. Southern division sales will be in charge of George E. Darden whose office will be in Memphis, Tenn.

★ NATIONAL HEADQUARTERS OF the Society of Plastics Engineers has been moved from Chicago to 3262 Lansmere Road, Cleveland 22, Ohio.

★ AMERICAN SECTION OF THE Society of Chemical Industry, Brooklyn, N. Y., has elected Dr. Elmer K. Bolton, chemical director of E. I. du Pont de Nemours and Co., Inc., Wilmington, Del., to receive the Perkin Medal. Dr. Bolton will be awarded the medal for his outstanding accomplishments in the field of industrial research.

★ DR. RICHARD M. HITCHENS HAS been promoted to the position of associate research director of the Organic Chemicals Div., Monsanto Chemical Co., St. Louis, Missouri.

★ FOR THE PURPOSE OF CONsultation on Government regulations, Morris L. Ullman, formerly Chief of Industrial Section, Los Angeles District, O.P.A., and plastics specialist in the O.P.A. at Washington, D. C., has opened offices at Chapman Bldg., 756 S. Broadway, Los Angles 14, California.

★ ROBERT R. COLE, VICE-PRESIdent of Monsanto Chemical Co., St. Louis, Mo., and general manager of the phosphate division, has been elected a member of the Board of Directors, filling the vacancy caused by the recent death of John C. Brooks, vice-president and general manager of the company's plastics division.

★ THE RESEARCH STAFF OF BATtelle Institute, Columbus, Ohio, has been augmented by the appointment of Dr. Arnold J. Veraguth to its division of organic chemistry.

★ J. BART BATTY, DISTRICT MANager of the synthetic resins department of the Detroit branch of Hercules Powder Co., has resigned to enter private business as a plastics consultant. Wallace Trowell will represent the company in the synthetic resins field for that territory from his office in Cleveland, Ohio.

★ ANNOUNCEMENT IS MADE OF the association of George W. Whitehead with the Plastic Molding Machinery Div., Improved Paper Machinery Corp., Nashua, N. H. Mr. Whitehead, who was previously connected with Hercules Powder Co. and Monsanto Chemical Co., is a member of the Thermoplastic Sub-Committee, Society of Plastics Industry and of the American Chemical Society. In his association with Impco, he will serve in a sales engineering capacity.

★ MASTERCRAFT PLASTICS CO., Inc., has been formed by Foster Monaco, R. Monaco and E. W. Levien, all formerly of Ivorycraft Co., Inc. The new company will be located at 95-01 150th St., Jamaica, New York.

★ H. E. BACK, JR., HAS BEEN MADE director of technical service in the Resin and Adhesive Division of Pennsylvania Coal Products Co., Petrolia, Pa.

★ A WEST COAST OFFICE HAS been opened by H. K. Porter Co., Inc., and Subsidiaries, Pittsburgh, Pa., at 849 Petroleum Bldg., Los Angeles, Cal. Harold A. Hintz will serve in the capacity of district manager for the territory.

★ THE PLASTICS DIVISION OF York Research Corp. has moved its offices from 101 Park Avenue to 63 Park Row, New York, N. Y.

★ THE RESIGNATION OF THOMAS K. Almroth, general advertising manager of Owens-Illinois Glass Co., Toledo, Ohio, has been announced by the company. Mr. Almroth has not yet made known his future plans.

★ S. W. ANTOVILLE, FORMERLY vice-president in charge of midwestern operations of United States Plywood Corp. at Chicago, will assume the newly created post of director of sales in the New York office.

★ J. O. ROSS ENGINEERING CORP., New York, N. Y., has opened a branch office at 79 Milk St., Boston, Mass., under the supervision of Frank W. Partsch, vice-president of the company.

Sorry!

★ IN THE ARTICLE "THE 6 x 42 BInocular" which appeared in the October 1944 issue, the type of filler used with Phenolic plastic "C" was incorrectly stated in Table I. A long-fiber cotton is used with No. 1 phenolic plastic "C" and short-fiber cotton with No. 1.

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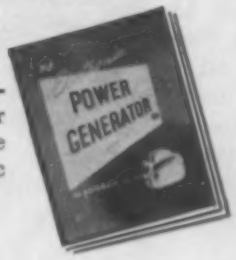

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Creep characteristics

(Continued from page 158)

Shrinkage has been observed to occur in plastics gradually over a period of time partly as a result of change in moisture content. The only creep tests for which shrinkage was measured simultaneously with creep readings are the tests of Mitscherlich paper and Grade C laminates. The shrinkage was measured in a specimen which was not subjected to load. Then the magnitude of shrinkage was subtracted from the creep readings in plotting the data shown in Figs. 8 and 9. When the corrected and uncorrected data were compared, it was observed that the shrinkage changed only the value of the coefficient m.

Other aging phenomena such as changes in internal structure with time may, however, result in such changes in creep characteristics that after long times the creep may depart from the relations described above. It is also probable that after relatively large strains (from creep), minute cracks may begin to form in the material with a resulting change in creep characteristics—such as, perhaps, an increase in the time power n. As pointed out above, constant load creep tests do not yield constant stress conditions when the resulting creep is large—due to reduction in cross-section. This error, however, is small for creep of 2 or 3 percent and is, therefore, of little importance for any of the materials considered here except cellulose acetate.

Effect of stress on strain and time for fracture

It has been observed in creep tests of both plastics and metals (3, 12) that fracture may occur after long periods of time at a constant stress much less than the ultimate strength of the material obtained for the same temperature. Thus it would be unsafe to extrapolate creep test data to very long times without having determined the length of time available before fracture would occur at the given stress. This time for fracture can be determined only from creep tests carried to fracture, or by extrapolation of data from time-for-fracture tests at higher values of stress. Unfortunately the elongation at fracture obtained from "static" test cannot be safely used as a measure of the strain at which fracture would occur in a creep test because it has been found (3, 12) that the strain at which fracture would occur in a creep test decreases with decrease in applied stress.

Comparison of creep properties of plastics

The values of all quantities used in the above analysis of creep data of plastics are tabulated in Table I. The first three materials tabulated are those tested at the University of Illinois and are listed in the order of their resistance to creep as measured by the total creep after 1000 hr. at 2000 p.s.i. It was observed that as the resistance to creep decreased, the modulus of elasticity of the material also decreased, the value of the power n and coefficient m increased and the value of the constant C_2 decreased, for a given stress value.

The data for creep tests of molded phenolics tested at the Monsanto Laboratory are summarized as items 4 through 8 in Table I. These materials are also listed in the order of their resistance to creep. Again in the case of these moldings the modulus decreases as the resistance to creep decreases (the woodflour molding is an exception). This correlation is probably due to the fact that the total creep includes both elastic and plastic deformation and the elastic deformation makes up the largest proportion of the total creep of phenolics at 2000 p.s.i.

Comparing the molded materials with the Grade C laminate, it was observed that the total creep was smaller for the moldings, the initial creep ϵ_0 was larger, the coefficient m was much smaller, and the power n was larger for the moldings than for the Grade C laminate.

Relation to the activation energy theory

The relation of the proposed power creep law to the Activation Energy Theory as proposed by Eyring (19) for chemical reaction rates and for diffusion has been applied to the problem of creep characteristics of metals by Kanter (20), Kauzmann (21), and Dushman (22) and others, and to the creep of thermoplastics by Kistler (8). This theory as applied to creep by these investigators is based upon an assumption that the creep-time relationship may be expressed in a linear form as given by Equation 1 of this paper. On this assumption these investigators defined the relationship between stress, temperature and the rate of creep v in accordance with the activation energy theory. The activation energy as related to tensile creep rate v by Kauzmann (21) is as follows:

$$v = \frac{2}{3}\frac{\lambda}{L}\frac{kT}{h} e^{\frac{\Delta S^*}{R}} e^{-\frac{\Delta H^*}{RT}} e^{\frac{qAl\sigma}{2kT}} \quad \text{(Equation 12)}$$

in which v is the rate of creep, T the absolute temperature, σ the tensile stress in lb. per in., k the Boltzmann constant, h the Planck constant, R the gas constant, λ, L and A dimensions of the unit of flow, q a stress concentration factor, l the distance through which the shear stress acts in carrying the unit of flow from the normal to the activated state, ΔS^* entropy of activation per mol, and ΔH^* energy of activation per mol.

In the opinion of the author the fact that plastics do not creep at a constant rate does not necessarily rule out the possible application of the activation energy theory to creep of plastics. This assertion may be explored further as follows: The rate of creep is defined mathematically as $\partial\epsilon/\partial t$. Performing this differentiation on the power function (Equation 3) the following relationship is obtained for the rate of creep in terms of the time t:

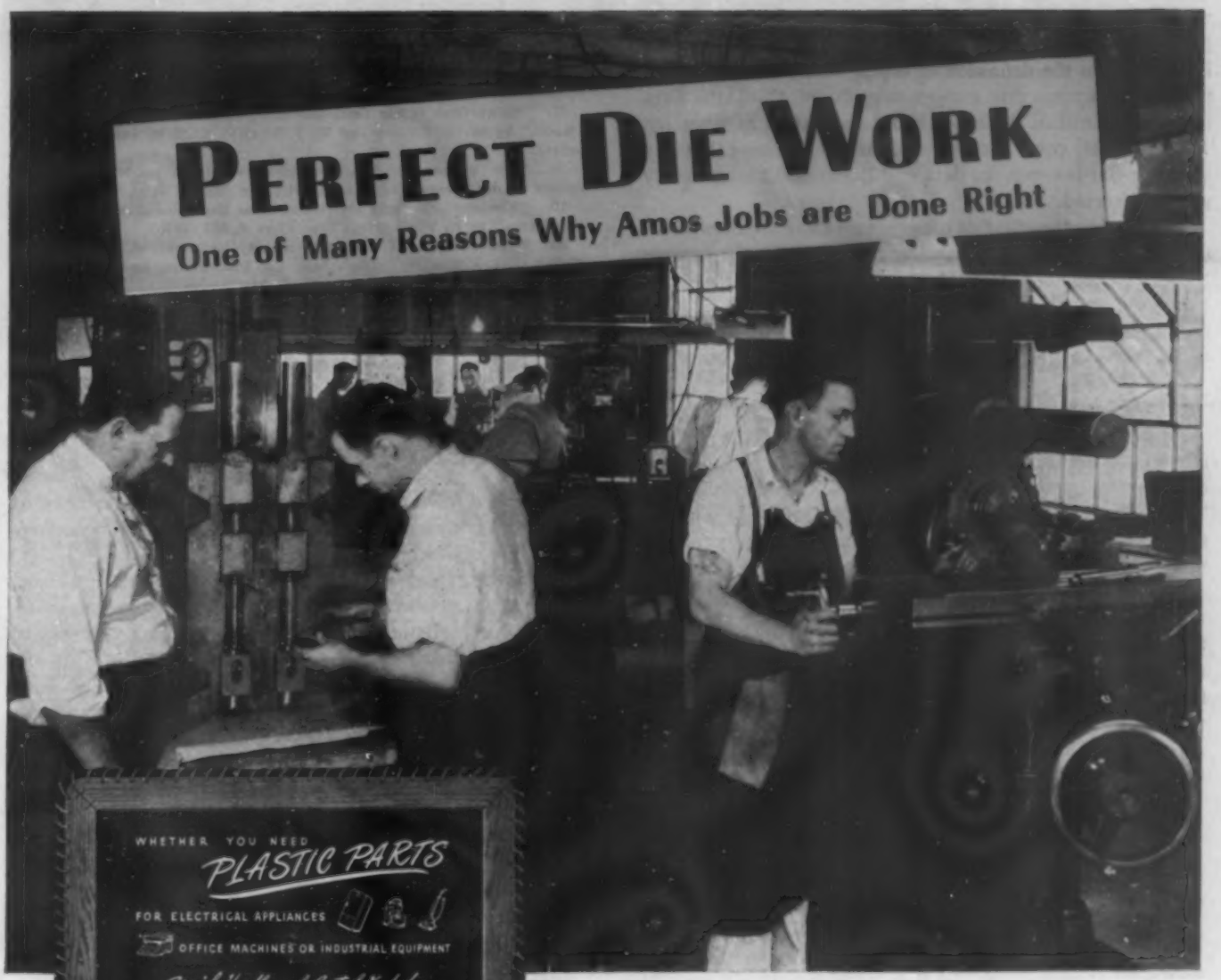
$$v = \frac{\partial \epsilon}{\partial t} = mnt^{n-1} \quad \text{(Equation 13)}$$

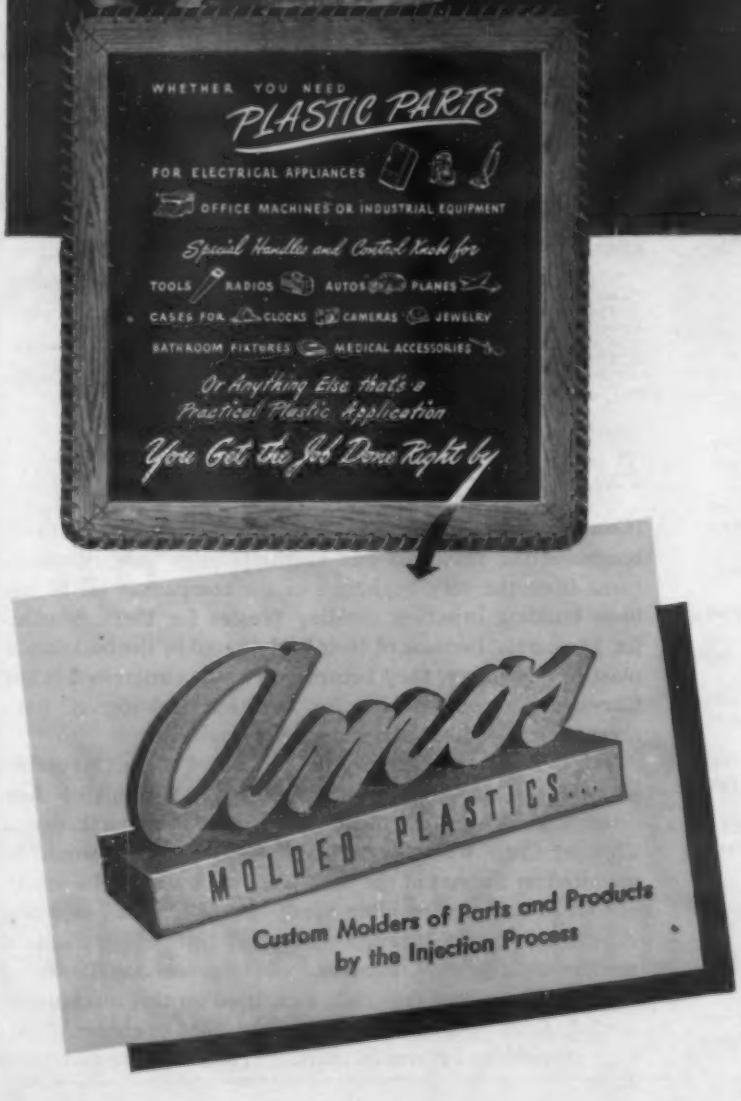
From this relationship we see that for a particular time t the rate of creep is dependent upon the product mn. Now the rate of creep, according to Kauzmann, depends upon the stress as an exponential function. It was shown above that the factor m, which is a part of the expression for rate of creep, was an exponential function of the stress (Equation 7) for the two laminates tested and that n was independent of stress. The agreement between Equation 7 and the data shown in Fig. 10 would seem to indicate that the exponential function is a possible relationship between m and stress σ and that the stress factor in the activation energy theory may be applicable to creep of plastics even though the creep-time relation is not linear.

Substituting Equation 7 into 13 the creep rate equation becomes

$$v = C_2 (e^{k\sigma} - 1)nt^{n-1} = C_2^{k\sigma}nt^{n-1} - C_2nt^{n-1} \quad \text{(Equation 14)}$$

Comparing Equation 14 with Equation 12 it is found that complete agreement would exist for a linear creep-time relation, i.e., $n = 1$, if the second term of Equation 14 did not exist. However, it seems reasonable to believe that Equation 14 is the more correct at least for the laminates tested; first, because the data shown in Fig. 10 satisfy Equation 14 but

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would not satisfy Equation 12; second, because Equation 12 predicts a finite creep rate at zero stress (a condition which is contrary to the definition of creep) whereas Equation 14 predicts zero creep rate at zero stress; and, third, the data for creep of metals presented in substantiation of Equation 12 (20, 21, 22) cover such a small range of stresses that any disagreement between the data and Equation 12 might easily pass undetected.

In regard to the effect of temperature there are insufficient data to evaluate the relationship of the activation energy theory to the effect of temperature on the creep of plastics. Further creep studies of plastics over a range of temperatures and stresses are needed in order to establish the validity of the activation energy theory to creep of plastics.

Summary

An interpretation of creep test data by means of a power function of time has been presented. The interpretation has been applied to creep of several plastics with good agreement. The results for plastics indicate that this method of interpretation may permit reliable extrapolation of creep data for the prediction of creep behavior at times greater than the extent of available tests.

This method of interpretation has also been considered in the light of the activation energy theory. This study showed that agreement with this theory may be expected but that further test data for several stresses at each of several temperatures and for a long time interval are necessary before agreement with the activation energy theory may be satisfactorily demonstrated.

Acknowledgments

The author wishes to express his gratitude to F. B. Seely for assistance in preparing this manuscript and to W. J. Worley, W. I. Mitchell and C. D. Kacalieff for their help in analyzing the data and preparing the drawings for this paper.

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Hard chromium plating

(*Continued from page 145*) plastics. Plastic materials do not stick to drills, reamers, cutoff tools, broaches, form cutters and a host of other standard tools.

There is an ever increasing use of hard chromium plating throughout industry. Many other parts, such as cams, crosshead guides, spindles, etc., have been chromium plated satisfactorily for years. Not only is this plating comparatively economical, but the chromium can be precision plated since, in an ordinary bath, it is applied at the rate of 0.001 in. per hour. In other words, only 0.0001 in. is plated in 6 minutes. Proper plating is considered an art because of the poor throwing power of the bath and the fact that chromium tends to build up on an edge. There are remedies for all this trouble, however. Incidentally, plastics play an important part in these plating processes because various plastic materials have been found to stand up in standard chromium baths. Thus, certain plastics have become accepted among chromium platers for use as shields and insulation.

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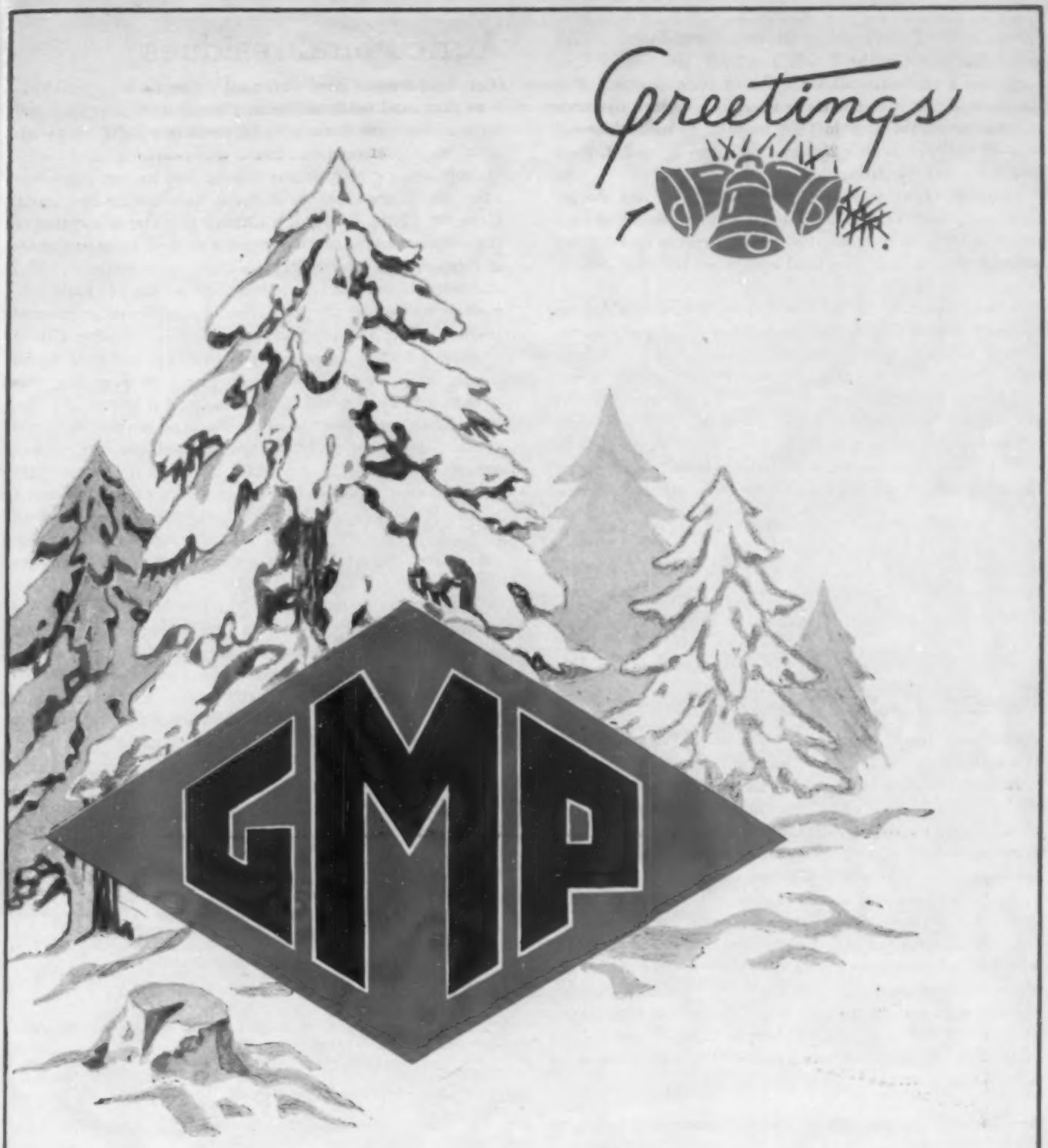
A multi-purpose machine

(*Continued from page 141*) molding presses for various thermosetting materials and thermoplastics were manufactured from the very beginning of the company. HPM has been building injection molding presses for thermoplastics for 13 years. Because of their background in the building of plastics machinery, they became very much interested in the Chrysler plastics machine for injection molding of both thermosetting and thermoplastic materials.

The Chrysler injection head appeared quite favorably adapted for use on their equipment. As a result of their interest, a working agreement was arranged between them and Chrysler Corp. whereby a Chrysler injection head would be mounted on the end of the fixed stationary platen of a standard HPM injection molding press. HPM built an injection head based on our drawings and installed it on the standard model 100-H-4, 4-oz. injection molding press as shown in Fig. 21. Numerous materials were tried on this machine including Buna S, Neoprene, wood-flour-filled phenolic, paper-base phenolic and thermoplastics. (*Please turn to next page*)



Molders of Plastics

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A 4-cavity die was built for this experimental work. Each cavity was of box design, $5^1/_2$ in. long by $2^1/_8$ in. wide, $2^1/_8$ in. deep and a uniform wall thickness of 0.090 inches. This particular design was purposely selected in order to provide information on the ability of the machine to mold thin wall sections under difficult conditions. Figures 22 and 23 show four boxes and the gating.

The mold clamp was only 100 tons capacity and molded these parts with very little flash. The total weight of each shot was $14^1/_2$ oz. including the gate and runners. Each box weighed $3^1/_8$ oz. and the total weight of the four cavities amounted to $12^1/_2$ oz. net.

It took 30 sec. to fill the mold; the nozzle was held down against the mold for another 15 sec. after filling and then the die was held closed $1^1/_2$ min. for curing the shot, making a total cycle of $2^1/_4$ minutes. The temperature of the die was maintained between 350 to 375° F. The injection pressure at the nozzle was 18,600 lb. per square inch. HPM at present is building a 200-ton mold clamp with the Chrysler unit attached. They have named the injection head "Turbojector" to distinguish the Chrysler unit from other injection heads.

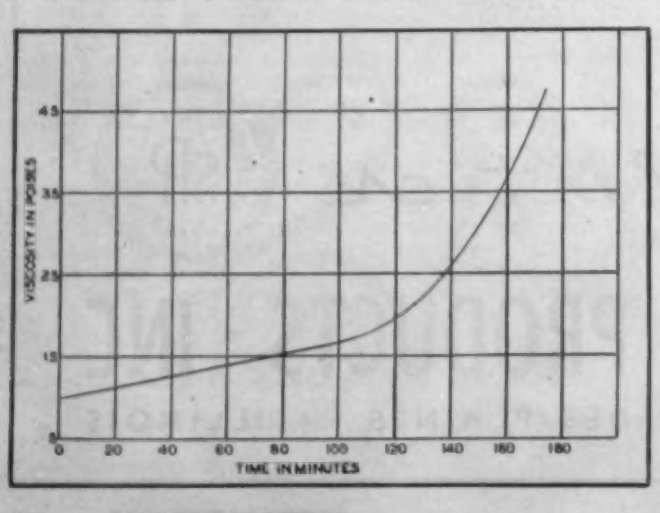
More complete details on the work done by Plastics Engineering Inc., toward the development of this plastics machine can be found in issue No. 44 of the Plastics News. Reprints of this bulletin may be obtained without cost by writing to Plastics News, 122 E. 42nd St., New York City, N. Y.

Resorcin resins

(*Continued from page 161*) resins have been employed as bonding agents in assembly gluing of laminated and molded phenolic parts as well as methyl methacrylate resin, nylon, allyl polymers, and even natural and synthetic rubbers. By treating metal surfaces with baked priming coatings of certain thermosetting resins, excellent bonds are obtained by applying resorcinol resins as bonding agents.

The potential use of these resins as adhesives is unlimited in postwar civilian applications—parts for marine use, aircraft, furniture, building construction and many others—where high strength and great durability are required. Examples of their uses in applications other than adhesives are laminating, molding, casting, coatings, grinding wheels, etc. Their compatibility with other resins as well as the possibilities of copolymeric modifications also hold the forth promise of a brilliant future.

4—The average pot life of G-1131 resorcinol adhesive



Agricultural residues

(*Continued from page 164*) used. The resulting products were plasticized with aniline and furfural, with phenol and furfural, and with furfural alone, yielding 148 different compositions. Compositions from water-cooking and acid-hydrolysis have very similar flexural and impact characteristics which are superior to those from aniline-hydrolysis. However, plastic flow and resistance to water absorption of the aniline compositions are superior to these same properties in compositions produced by the other three methods. The characteristics of the aniline compositions tend to indicate a possible method for the production of resins from agricultural residues. The alkali-furfural treatment, in its present stage of development, is not considered a suitable method for preparing molding compositions. Further developments in this field may produce a satisfactory treatment, however.

Under the experimental conditions used in these tests, the types of treatment given the raw materials and the types of plasticizers employed apparently have much greater effect upon the characteristics of the compositions than do the raw materials themselves. In general, the residues investigated might be used interchangeably in the preparation of these plastic molding compositions without significant differences being observed.

The data presented indicate the possibility of the use of various agricultural residues in the production of molding compositions. A considerable amount of further experimentation will be necessary before the commercial application of these raw materials and methods can be considered as a practical matter. The possibilities suggested, however, give promise of interesting developments with these materials.

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Aluminum and Plastics

MAKE A GOOD TEAM

It's been going on for a long time, this teaming up of aluminum and plastics. In combination, the two materials do a lot of jobs which neither could do as well by itself. Designers and manufacturers will find in the following tabulation the properties which make versatile aluminum so highly desirable when used alone and with plastics.

LIGHTNESS WITH HIGH STRENGTH—The light weight of aluminum is its most striking quality; lightness with high strength. It weighs only one-third as much as the heavy metals.

RESISTANCE TO CORROSION—Aluminum is able to resist the corrosive action of the atmosphere and a great variety of chemical compounds.

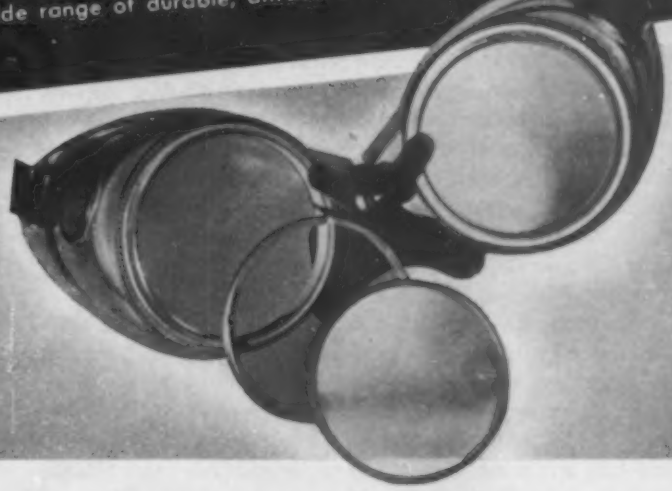
HIGH THERMAL AND ELECTRICAL CONDUCTIVITY—Heat is distributed rapidly throughout its mass, usually permitting higher ratings. And aluminum is also an excellent conductor of electricity.

NONMAGNETIC AND NONSPARKING—Being nonmagnetic and nonsparking, aluminum is especially desirable for many products and devices.

EASY TO FABRICATE—Alcoa Aluminum Alloys are available in every commercial form and are easily fabricated by all common methods. They can be economically finished in a wide range of durable, attractive surface finishes.

Strength to spin at high speeds; armed against corrosion. This is a resin-coated spinning bucket employed in the textile industry. Forged from a strong Alcoa Aluminum Alloy, it spins safely at 14,000 rpm. Its baked phenolic resin coating protects it against attack by the chemicals employed.

An aluminum ring carries this plastic dome. Wartime products, like this navigator's dome, include many examples of aluminum and plastics working together, each material contributing some desirable property to the finished product.



These threads are aluminum in a plastic frame. A plastic provides the transparency and light weight desired for these industrial goggles. But aluminum threads were added to give stiffness to the frames and durability to the threads.

Aluminum and plastics are teaming up similarly in peacetime products.

ALCOA

ALCOA ALUMINUM

A pressure-tight grommet

(Continued from page 107)

The results listed above would seem to hold forth great promise for a full use of the plastic blind grommet in the future. The design of the unit makes it suitable for laminated constructions, and the plastic grommet's unlimited color possibilities combined with its air-tight seal will make it a factor in the air-conditioning of modern houses. Furthermore its decorative value and low cost suggest its extensive application for electrical and plumbing fixtures. Producers of automobiles, radios and all electrical devices should be interested in this development as a means of streamlining the production and increasing the future sales appeal of their merchandise.

Credit—Molded by Victory Mfg. Co.

Hobby lobbying

(*Continued from page 99*) products of that effort and get back your whole investment."

Making what—that was the question. But even as he mentioned a dozen or more simple articles, Mr. Utley was displaying products of his handicraft which explained his belief more clearly than words. Literally hundreds of items filled the shelves. Some were as clear and shiny as fine crystal, others were radiant with color. Many of the pieces were of solid color—the result of being dipped in dye. Still others were crystal white, but suffused with a tinted luminescence. Close examination showed that these pieces had but a spot of color, so located that the light-channeling property of the material sent colored rays throughout the entire article.

A number of the plastic items were merely abstract shapes, lovely in tone texture and design, the results of Mr. Utley's experiments with refraction and color. But most, by far, were functional items: trays and boxes, containers for cigarettes and cosmetics, exotic perfume stands, picture frames, hand mirrors and bottle holders. There was an ingenious "build your own lamp" set, consisting of bases, pillars and heads, that could be assembled in a wide range of different lamp designs.

Mr. Utley picked up half a dozen of the simpler items. "There are at least fifty pieces in this room that could be made by a beginner after a short period of learning his tools and his materials. The trick of producing attractive and unusual items is to utilize light refraction. Take for example these pocketbook ornaments and transparent shoe buckles. With correctly angled cuts and a good finish, these things can sparkle like diamonds. Even the average industrial manufacturer hasn't taken full advantage of the refraction possibilities of these materials. Give me any man who has any manual facility at all and I'll give him a hobby that will delight his soul and, if he's at all interested, offer him real income possibilities.

"There is one factor that most people haven't realized," Mr. Utley continued. "The work of European craftsmen is no longer available and probably won't be for a long time. American stores are going to turn to American craftsmen for their stocks, and these craftsmen are going to develop a new folk art, in addition to improving the old. And plastics will play a leading part in this movement. In addition to machineable and moldable materials, there will be a wide range of synthetic fabrics and yarns, liquid plastics and viscous plastics. We have them all now, of course, but in the post-war era they will be available in a form that the home hobbyist and worker can use."

Already a start has been made in this plastics program for returning servicemen. Many handicraft associations are giving the material extensive publicity. Store buyers are constantly on the lookout for new sources of supply. Articles are appearing from time to time in the daily press and in magazines. Movies are being made on the subject.

But all this, in Mr. Utley's opinion, represents a beginning. There should be an intensification of the work already being done—increased publicity, more films. In addition, there is a need for books which will treat the subject clearly and simply so that anyone interested in working with plastics can learn by himself without taking class instruction. Mr. Utley also feels that sources of supply should be set up directed toward filling the needs of home crafts workers. Tools will be needed by the beginner, and simple adapters for metal or wood tools will be in demand by those who have engaged in other types of handicraft but want to make their equipment better suited for work on plastics. And finally, avenues for selling the product of these home workshops must be discovered so that this hobby can serve to augment rather than to deplete the income of the worker.

Eye section for B-29

(Continued from page 148)

A method much in use today throughout the industry is the free blowing of sheet material. To describe it briefly, this free-blown method involves the clamping of the edge of the sheet so that it is air-tight. Air is admitted and the plastic inflated until it reaches the correct height and assumes the shape of the restraining rings. Inasmuch as there is no contact with any form, danger of marring the sheet is non-existent. This method is simple to arrange for the production of blisters, fighter canopies and streamlined shapes. However, the disadvantage lies in the fact that major contour lines which might be important for aerodynamic reasons cannot be held. It is felt, however, that better optics might compensate for this possible loss.

Another method was developed at the Bell Aircraft Corp. as a result of the discovery that "mark-offs" can be eliminated in stretch forming provided the male form is kept in a constant state of vibration. Following this procedure, a large fighter canopy which most companies would free blow was stretch formed with excellent results. The main purpose was to preserve the contour lines—impossible in free-blown canopies—and at the same time, keep optical qualities good. Despite the terrific stretch, the parts were formed satisfactorily and passed critical inspection.

It would seem that the ultimate and most successful method in the forming of acrylic sheets to preserve original contour lines and good optics would be to use a vacuum pot in conjunction with the moving form block in the forming of all compound curvatures and deep draws. That is, the plastic should be vacuumed roughly to the shape desired, and the male form lowered into the opening of the pot. The plastic may then be allowed to snap back and drape itself around the male form which is vibrating slightly. When cool, the plastic will be found to have assumed the desired lines and to be free from "mark-off."

In forming slight 3-dimensional shapes, good optics may be obtained by the stretch method alone, providing the hot plastic is kept in a state of motion while being formed. This method can also be used in the free-blowing sections. When a

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specific area must be restrained in a given part—as in flat sections designed for streamline or for sighting purposes—the desired result can be accomplished by inflating the section until contact is made with the shaping form for the area under discussion. This shaping form should be built so that it can be kept in constant movement.

Our findings in the forming of plastic sheets using this buffing action, also indicate that the method lessens the tendency of the material to thin out in areas of greatest draw. Considerable thought may also be given to use of this method in windshields where simple curved sections are needed and good optical qualities are a prime requisite. This will minimize surface variations in imperfect cast sheeting. The company believes it is now possible to form sheeting that will rank very closely with curved safety glass.

The Bell Aircraft Corp. has not yet found it necessary to buff formed parts, and would not recommend this procedure in a forming department since it has been found to be more harmful than helpful in a formed transparent plastic. If the plastic is formed correctly, buffing will automatically be eliminated. In field conditions, of course, light buffing is sometimes necessary.

Credits—Material: Plexiglas, Lucite, Lucite-Butacite. Formed by Bell Aircraft Corp.

Assembly line packaging

(*Continued from page 116*) convenient handling time. This slow withdrawal accomplishes its purpose in two ways. The bottom of the plug—the metallic part—possesses the greatest mass, and tends, therefore, to heat more slowly than the ceramic section of the plug. The slow withdrawal gives the bath more time to heat this section so that the film on the surface of the steel is less viscous and permits better flow off the lower section where the ethyl cellulose tends to accumulate. Secondly, the slower withdrawal permits the same phenomena that takes place in paint dipping. Tension displayed by the top of the bath tends to "wipe" the excess coating from the surface of the plug as it is slowly pulled through this film.

Keeping in mind the results of laboratory work, an automatic machine was designed, capable of strip coating a minimum of 50,000 spark plugs daily. The machine (Fig. 1) has a dipping capacity of 4500 plugs per hour. The use of indirect heat makes possible the melting of 100 lb. of plastic per hour without any danger of the ethyl cellulose breaking down due to excess heating. Thermostatic control is maintained over both the heat exchange medium and the plastic to insure that neither rises over its maximum allowable temperature. The plastic is melted and preheated to proper temperature for dipping before it enters the dip tank section of the unit. Extremely close control (2° F. maximum variation) and uniformity of temperature is achieved with remarkably low heating-surface temperature.

The solid plastic is introduced at the loading end of the tank and reduced to liquid at the right-hand end of the heating pad. The overflow is reheated by passing under the dipping tank, over the reheating section of the heating pads and back to the pump.

This movement of the plastic has several advantages:

1. The film that forms on the surface of the material where it is exposed to the air is continually removed or prevented from forming because the surface is in steady motion.

2. Bubbles, which may form in the ethyl cellulose due to the immersion of the part to be dipped, are continuously removed over the weir.

3. The temperature of the plastic at the point of dipping is maintained absolutely uniform.

4. The level of the dipping surface is maintained without variation. The weir is adjustable so that the level of the dipping solution may be controlled for various sized parts.

The conveying mechanism, which carries racked plugs through the plastic dip tank and out to the packaging table, is a compact unit—the whole assembly taking up much less floor space than an installation using the wrapping method for an equal production. An overhead return conveyor allows time for the plugs to cool before they are packaged and keeps labor to a minimum since the persons engaged in racking the plugs can also remove the coated parts.

Credits—Material: Protektol using Hercules Ethel Cellulose or Dow Ethocel. Dipping of plugs by Corcoran-Brown Div., Electric Auto-Lite Co.

Washington round-up

(*Continued from page 190*) industry, like many others, is troubled particularly with container and manpower problems in addition to raw material shortages.

2. Continuation of controls over rotenone, pyrethrum, arsenic and copper fungicides has been asked by the industry advisory committees. They are, of course, particularly troubled because pyrethrum and rotenone come largely from the Pacific battle areas.

3. Retention of the photographic film order, L-233, after the defeat of Germany was recommended by the Photographic Film Manufacturers Industry Advisory Committee.

4. The Automotive Wholesale Industry Advisory Committee recommended lifting of restrictions on replacement parts but said that the period necessary for reconversion would be several months. Some members even wanted retention of distribution regulation.

5. Chlorine allocations should be continued for at least one month, according to the recommendations of the advisory committee for that industry.

6. Continuation of controls on commercial-type motors for use on such things as washing machines, refrigerators, etc., was recommended.

7. The effect of a possible conflict in revoked and unrevoked orders is illustrated by the glass situation. There will be plenty of glass but a shortage of tin needed for closures and of containers needed for shipment.

8. The newspaper and printing committee has requested a continuation of all orders affecting paper supply.

9. Scheduling order continuation even after "V-E" Day on manufacture of metal-clad switchgear, and oil-and-air circuit breakers, was requested by industry members.

10. The softwood plywood industry has asked for continued control after "V-E" Day.

11. Tracklaying tractors are another product which manufacturers insist should be kept under control after "V-E" Day.

12. Another angle of the attempt to decentralize and liberalize production came when committee members of the commercial cooking equipment industry opposed decentralization because they believe it would result in substantial increases in the number of applications.

13. The request of the paper and copper wire industries for retention of controls has already been reported in an earlier bulletin.

14. Just a few days ago Mr. Krug announced that controls would have to be retained on leather and textiles.

15. It is also probable that the container order L-317, which practically tells everyone how many shipping containers he can have, will be kept on indefinitely.

Meeting Every Bearing Requirement

IN THE PLASTICS INDUSTRY

Wherever wheels and shafts turn in plastics production, Timken Tapered Roller Bearings make them turn smoother; faster; truer; longer.

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TAPERED ROLLER BEARINGS

Radio tube bases

(*Continued from page 113*) Fig. 7. The two large pins which appear at the right of the force plate in this illustration are merely guide pins—standard equipment on all molds for lining up the two plates.

Not so many years ago, most radio tube bases had the contact pins molded in. Today, due to the development of new pin assembling equipment, it is more economical to assemble the pins after molding. This operation, known as pin staking, is completely automatic. It is only necessary to load the radio tube bases in one hopper and to put the formed pins in another.

While this particular molding equipment was designed for a specialized job, equipment for this type of molding operation can, undoubtedly, be adapted, with very little change in the machinery, to the molding of many types of products. Our hats are off to the engineers and designers at this molding plant for the development of this automatic machine.

Credits—Material: Durez. Molded by Bridgeport Moulded Products, Inc., for Sylvania Electric Products, Inc.

Lighting fixtures

(*Continued from page 109*) in the form of a complete circle and suitable for use with inductive or resistance ballasts. The resistance ballast can be used for the 20-watt lamp and makes a relatively inexpensive lightweight portable table lamp of approximately 85 watts. It has been suggested that in the portable floor lamp one 40-watt fluorescent lamp might be used in combination with a modified R-40 incandescent lamp for indirect lighting. While this assembly would seem to be very satisfactory for portable lamps, its acceptance would seem to hinge on whether the public will demand an all-fluorescent portable rather than a combination unit. It is doubtful whether acceptance of the two can be predicted, and both forms should be made available."

In some of the portable lamps used in the test living room, the intention is to form the cones and shades from plastics although in the accompanying photographs (Figs. 7 and 8) these parts are merely suggested by cardboard and wood dummies. No specific recommendations were made for these units, beyond the suggestion that a relatively transparent plastic cone be used for well-diffused illumination.

By a change in furnishings, the test room was converted to a dining room (Fig. 5). Here it was proposed that a center ceiling luminaire be used—one room, at least, where such a fixture would seem logical. The fixture was a 4-light unit using 40-watt fluorescent lamps. This ceiling luminaire has quite large lateral dimensions but small vertical dimensions. Practically no metal is used and the entire enclosure, formed to the desired shape from cellulose acetate sheet material, is easily removable.

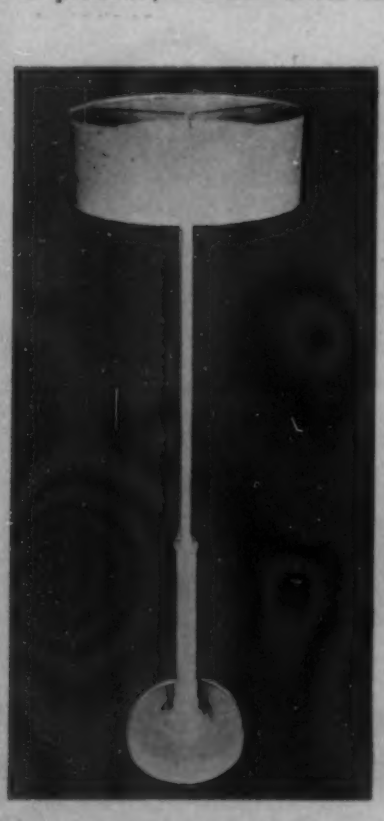
It is pointed out that only three different molds are required for an enclosure of this type—the right and left outer sections and an inner tray. With these three ceiling shade sections, panels having two, three, four or six lights can be produced merely by adding the desired number of inner trays. The four-light unit used in the test room provided about 45 foot-candles at the periphery of a 50-inch circle. The sample plastic enclosures (Fig. 6) have the same general characteristics as those used in the living room units.

This report by the Utilities Research Commission covers studies undertaken and still being continued by a task committee headed by Ralph G. Raymond of Commonwealth Edison Co., and including other representatives of the Chicago utility, the Public Service Co. of Northern Illinois, Western United Gas and Electric Co. and Illinois Northern Utilities Company. E. D. Tillson, Edison testing engineer, is in direct charge of the experiments.

The Commission in its study of lighting problems is giving further consideration to the use of thermoplastic materials.

Credits—Material for sample enclosures for ceiling fixtures, Fibestos. Molded by General Plastics Corp.

PHOTOS, COURTESY COMMONWEALTH EDISON CO.



***7**—One suggested design for a floor portable light employs two 40-watt circular fluorescent lamps. **8**—A plastic material was recommended for the cone and shade although wood and cardboard were used for these dummy parts*

FOR DIFFICULT PLASTICIZING JOBS LIKE THESE . . . INVESTIGATE

Paraplex G-25

APPLICATION	ELASTOMER	ADVANTAGES OF PARAPLEX G-25
Cable Jackets	Polyvinyl chloride and acetate copolymers	Non-migration, permanence, oil resistance, low heat deformation.
Cable Lacquers	Polyvinyl chloride and acetate copolymers	Non-migration, permanence, durability, heat stability.
Fabric and Paper Coatings	Polyvinyl chloride and acetate copolymers; cellulose acetate butyrate; cellulose acetate propionate; Neoprene, Buna N	Non-migration, oil resistance, durability, high finish, permanence, gloss, freedom from taste and odor.
Rigid Moldings	Polyvinyl chloride and acetate copolymers; polyvinyl chloride-Buna N blends	Good processing, toughness, low heat deformation.
Free Films	Polyvinyl chloride and acetate copolymers; acrylic polymers (ACRYLOIDS)	Good processing, toughness, permanence, oil resistance, non-migration.
Hot Melts	Polyvinyl acetate and copolymers	Heat stability, low acidity, permanence, freedom from taste and odor, wide compatibility range.
Gasket Stocks	Buna N; Neoprene; polyvinyl chloride and copolymers	Oil resistance, low temperature flexibility, permanence.
Gasket Coatings	Polyvinyl chloride and acetate copolymers; Buna N; Neoprene	Oil resistance, permanence.
Extruded Hose and Tubing	Polyvinyl chloride; polyvinyl chloride-polyvinyl acetate copolymers; Buna N; Neoprene	Oil resistance, non-extractability, permanence, facilitates processing.
Seam Sealing Compounds for Metal Containers	Polyvinyl chloride and acetate copolymers, Buna N	Permanence, heat stability, resistance.
Can Linings and Closures	Polyvinyl chloride and acetate copolymers; thermosetting phenol formaldehyde resins	Permanence, resistance, freedom from taste.
Cements	Polyvinyl chloride and acetate copolymers; Buna N; acrylic polymers (ACRYLOIDS)	Tack, permanence, non-migration.
Pressure Sensitive Adhesives	Polyvinyl chloride and acetate copolymers; acrylic polymers (ACRYLOIDS)	Non-migration, permanence, heat stability, tack.
Nitrocellulose Lacquers	Cellulose nitrate	Durability, non-migration, permanence.

THESE applications represent the fields in which PARAPLEX G-25 has already demonstrated its usefulness in the short time since its introduction by The Resinous Products & Chemical Company. The unusual properties of this non-migrating, oil-insoluble plasticizer suggest a much broader scope of utility. We shall be glad to work with you in studying the adaptability of PARAPLEX G-25 to your difficult plasticizing problems.

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Plastics markets

(*Continued from page 102*) countries as Argentina and Brazil, to set up profitable branch plant operations. Probably processes that utilize plywood and other laminates will make progress in South America since they are comparatively easy to set up and manage. It is well to remember that the entire Latin American molding industry has mushroomed in the last three or four years. The initial impetus came in 1937 with the importation of German injection molding machines and polystyrene molding compounds. Since then molding has made marked strides and there seems to be no question that there will be a substantial production of molding plastics by Latin America after the war.

Molding by extrusion

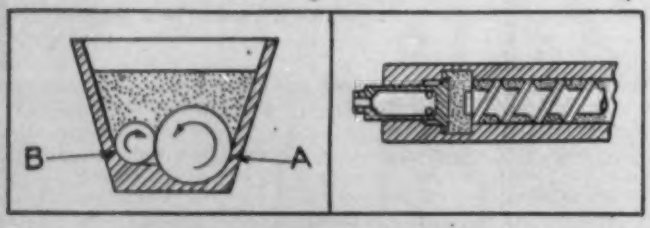
(*Continued from page 186*) however, it may be possible to use container *E* merely for raising the temperature of the powder and to arrange for the remainder of the heating to be done inside the barrel by the work done on the material in churning it up supplemented by heating with coil *C*.

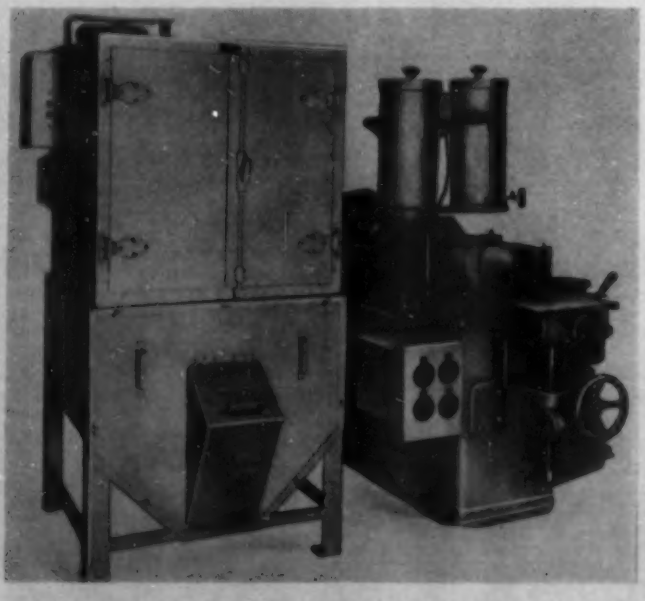
This method of molding possesses a number of noteworthy features. Owing to the relatively low molding pressure, it is possible to obtain accurate positioning of weak inserts and insulated wires. It has been found that the screw gets rid of any bubbles that happen to be present in the material—ejecting them at the hopper.

As the machine is of the continuous-feed type, very large moldings can be made by a small machine with a relatively low initial cost, corresponding low running cost and small floor displacement. Owing to the low pressure that is employed, the molds may be constructed of very light brass or low-grade steel which are low in cost. This has the advantage of enabling small quantity production to be carried out economically.

3—A roller feed assists the material to enter the screw. The roller feed A is driven by screw B by means of a spur gearing. *4—The automatic nozzle comprises a valve of the poppet type which has a hollow stem with circumference holes adjacent to the valve seat.* *5—Machine provided with an electric oven set on top of a storage bin*

3 4





5

Figure 2 shows a typical machine manufactured by David Bridge & Co., Ltd.[1] and driven by a Metropolitan-Vickers variable-speed motor through a double reduction-gear box. The forcing screw is of high tensile steel mounted in large sleeve-type bearings, and is provided with a suitable ball race for taking the end thrust. The whole assembly is easy to dismantle and reassemble for cleaning in the event a change is made in the type of plastic used. The hopper, barrel and container for the raw material are heated electrically by heating elements manufactured by Metropolitan-Vickers.

There are two main forms of nozzle—the plain and the automatic. When the plain nozzle (Fig. 1) is used, the machine must be started after the mold has been clamped on and stopped before the mold is removed. In the case of the automatic nozzle, the machine can be run continuously.

The automatic nozzle (Fig. 4) comprises a valve of the poppet type which has a hollow stem with circumferential holes adjacent to the valve seat. With the machine running continuously, this valve opens as soon as the mold is pressed against it and closes immediately the mold is removed. Since it is desirable to be able to operate the valve manually so that a cold cob of plastic which may have formed at the nozzle can be removed or so that the machine may be emptied prior to a shutdown period, a suitable hand lever working in conjunction with an eccentric spindle is provided.

It is desirable, in the case of repetitive work, to provide the machine with two or three nozzles of the automatic type, together with their associated adjustable tables in order to increase the productive capacity of the machine. In the case of a single-nozzle machine, one operator carries out the whole operation—the assembly of the mold with its inserts, the molding operation and the dismantling of the mold. The dismantling and reassembly of the mold are accomplished during the cooling period of the succeeding molding operation.

It is usually necessary to preheat the mold, and this may be done in a variety of ways. For example, the mold may be placed in a suitable oven or it may be preheated by means of a gas flame. Figure 5 shows a machine provided with an electric oven arranged on top of a specially designed storage bin in which the molding powder can be stored under clean and dry conditions.

Cooling of the mold can be accomplished conveniently by blowing air on to it from a compressed air supply or from a small power-driven blower. Again, the nature of the work may be such that the mold can be jacketed, and heated with hot water or steam and water cooled.

In the case of a 3-nozzle machine two operators are used. One is in charge of all molding operations. He operates the nozzles in rotation—filling only one mold at a time so as to avoid any fall in pressure which would occur if two or more molds were filled simultaneously. A second operator carries out the work of dismantling and reassembling the molds.

This method of molding should be regarded as supplementary to, rather than as competitive with, the present well-known methods. Although, up to the present, it has been confined to the molding of polyethylene there is every possibility of its use in a much wider field after the war.

[1] The machines described in this article incorporate several features for which patent application has been entered.

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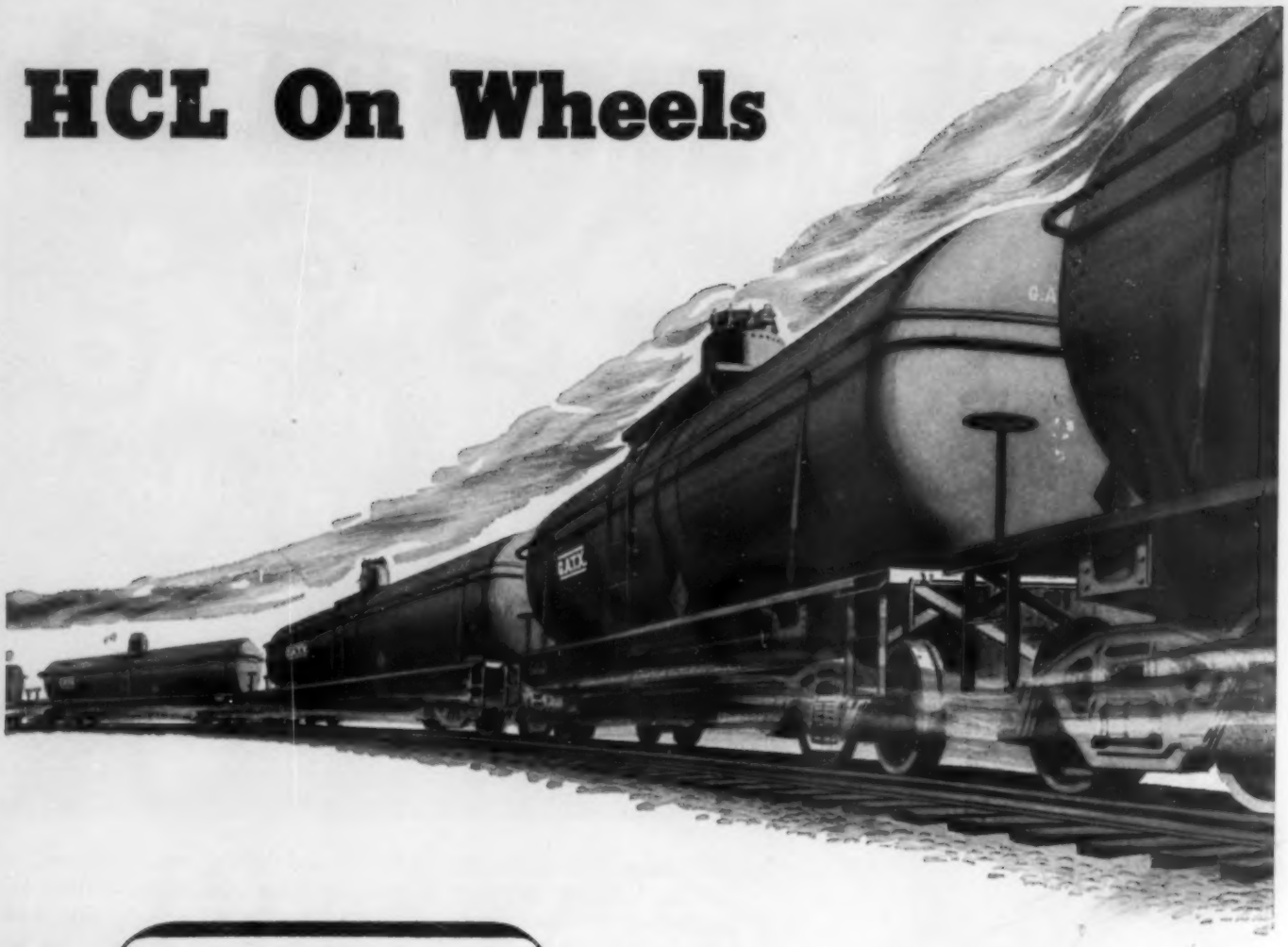

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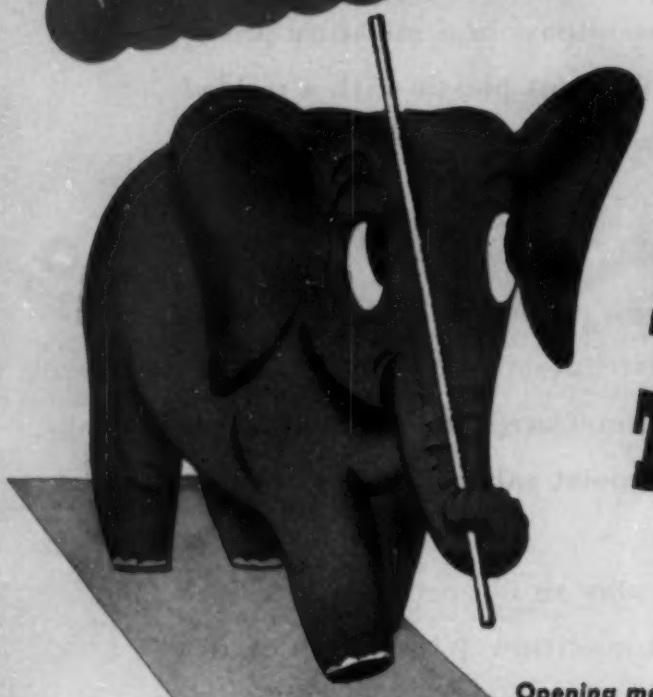

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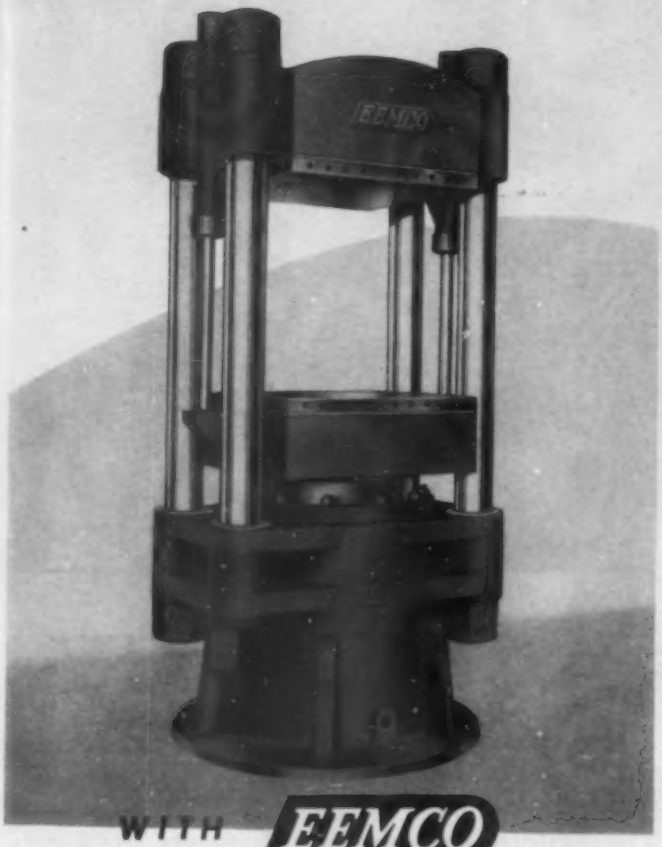

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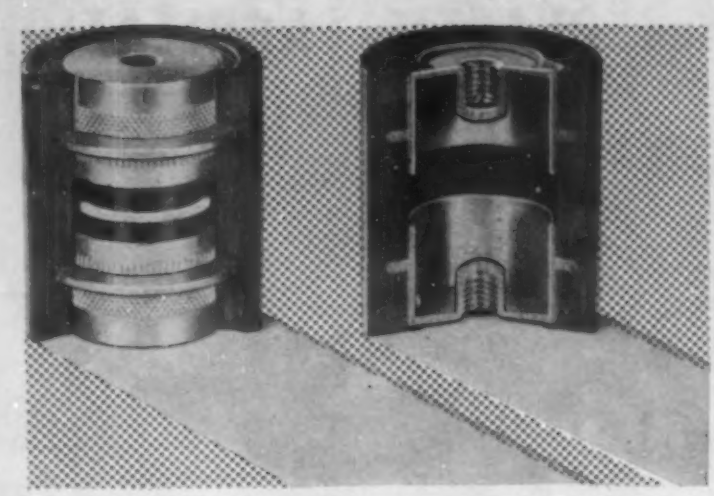

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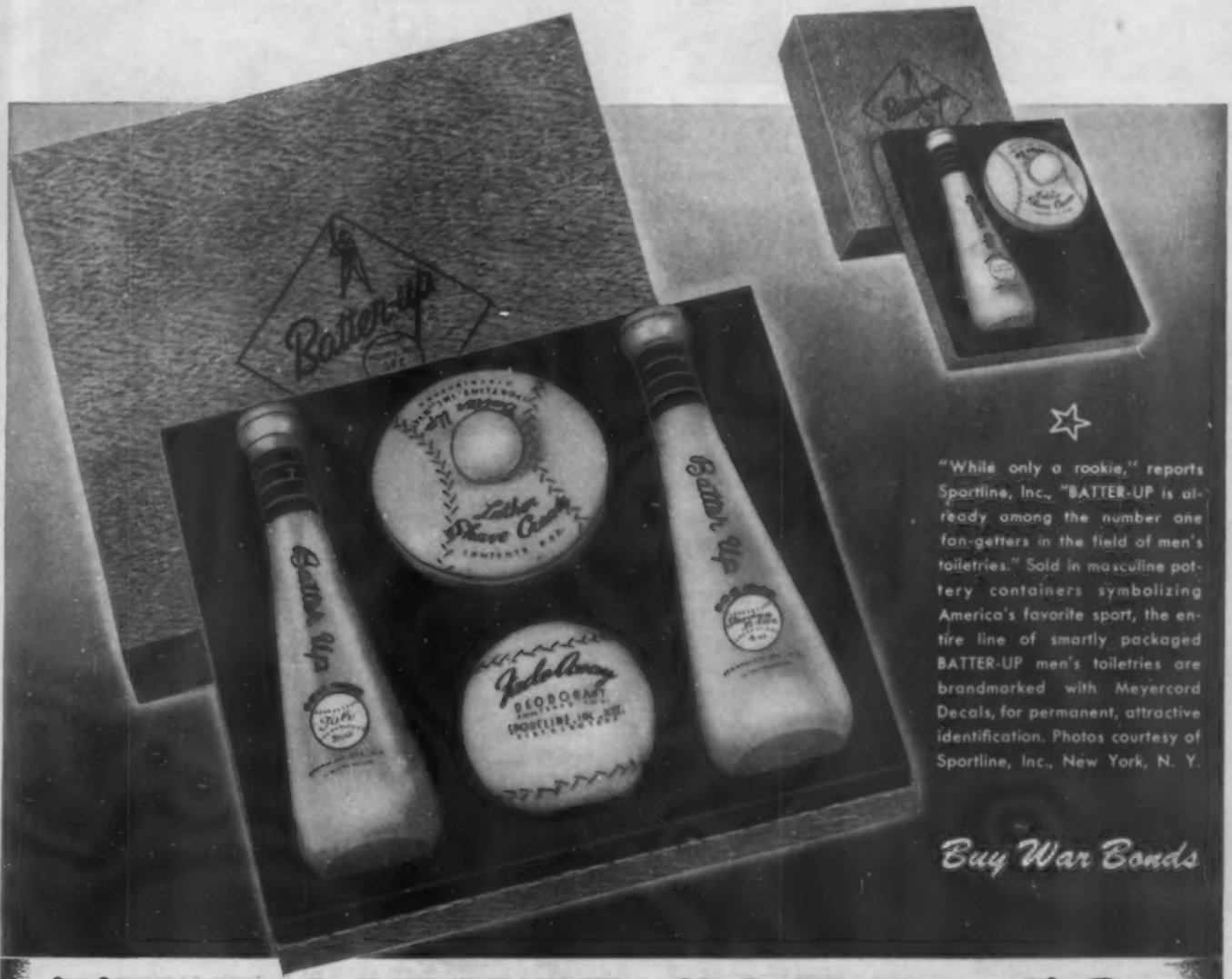

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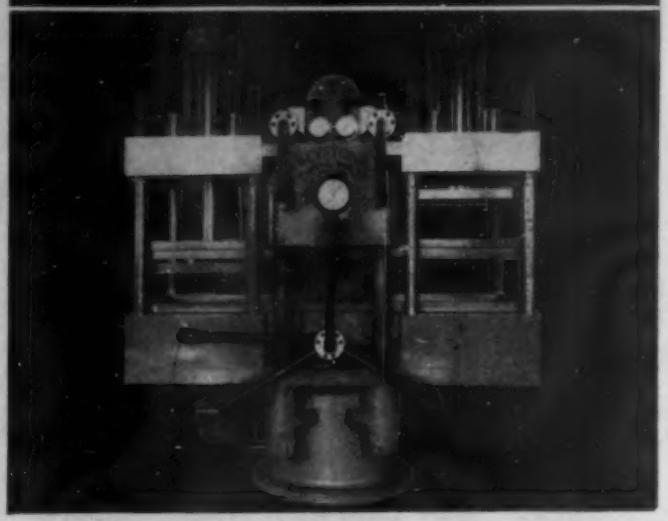

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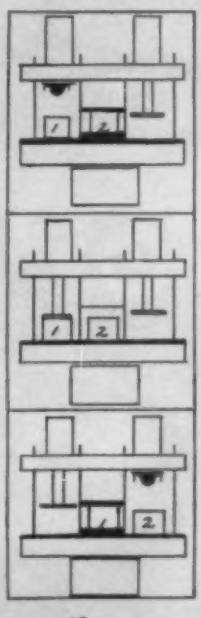

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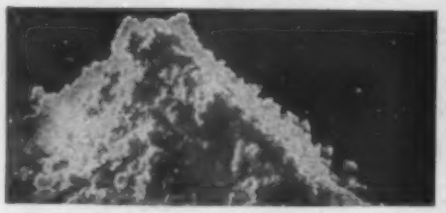

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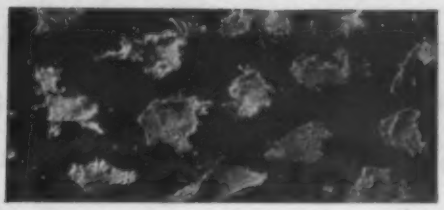

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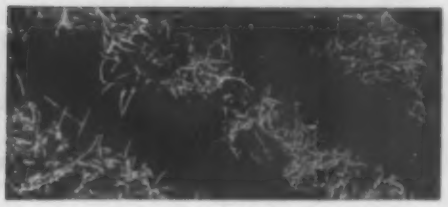

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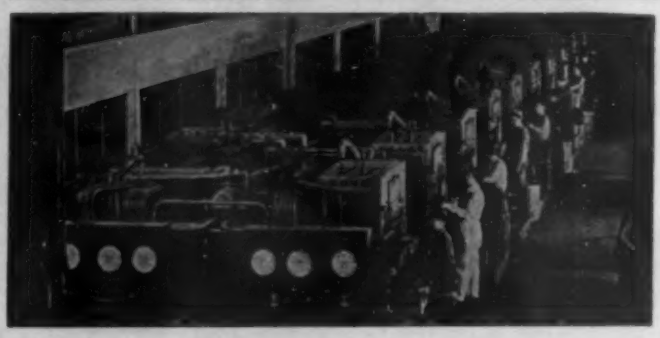

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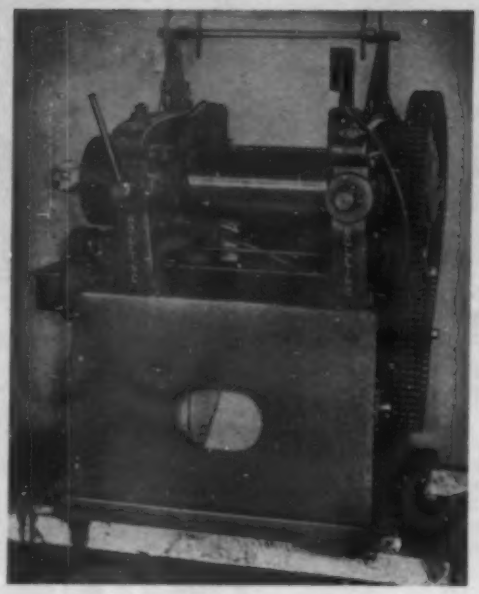

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Branch of the Industry	Name of Appliance	Use
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Molders (Thermo-plastic) Injection	VIBRA-VEYOR (Variable heat)	To preheat plastic powder automatically. To dry plastic powder automatically
Injection	HOPPER-HEATER (Variable heat)	To warm up heavy metal of hopper of molding machine
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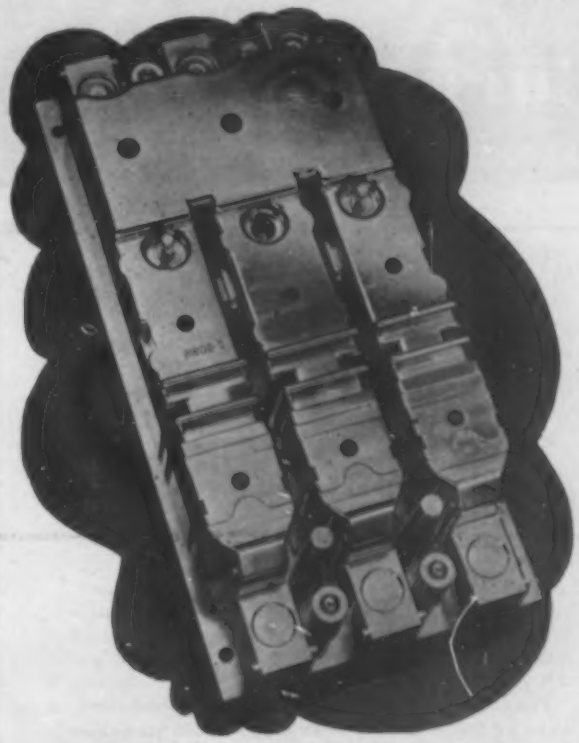

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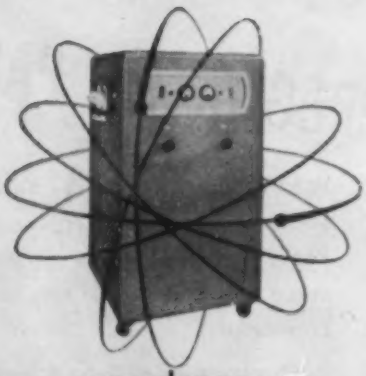

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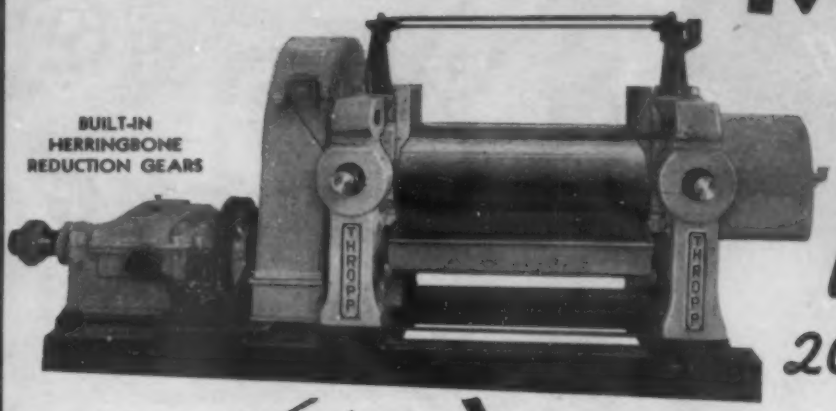

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WANTED: Small or medium size plastic injection molding plant, with or without tool shop. Advise full details. Detroit Production Company, 910 Majestic Bldg., Detroit 26, Michigan.

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Either injection or compression molds in good condition
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